AIRSTRIP PAVING MATERIALS

INTERIM REPORT AND HEARINGS

BEFORE THE

SUBCOMMITTEE FOR SPECIAL INVESTIGATIONS

OF THE

COMMITTEE ON ARMED SERVICES

HOUSE OF REPRESENTATIVES

EIGHTY-FIFTH CONGRESS

FIRST SESSION

UNDER THE AUTHORITY OF

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INTERIM REPORT

AIRSTRIP PAVING MATERIALS

Commencing on June 24 and concluding on July 3, 1957, the subcommittee conducted open hearings, which are included with this report, concerning a decision of the Department of Air Force to abandon the criteria established August 16, 1954, in agreement with this subcommittee. In that agreement, a 5 percent differential in favor of portland cement paving for airstrip runways and other areas was abandoned and specifications were provided for the alternate use in competitive bidding of portland cement and asphalt for runways and taxiways.

The Air Force has represented, in the course of its testimony, that increased loads by reason of the "channelized" traffic (i. e., repetitive use of the same areas) caused breakdowns on taxiways and runways.

Air Force, therefore, proposes that portland cement concrete be substituted as an exclusive material for these areas. For reasons which will hereafter appear, this will be an interim report. The subcommittee will not enter its final conclusions until the conclusion of the tests and the report and further hearing thereon.

But while the subcommittee proposes to suspend final judgment, it is agreed that, on the evidence so far adduced, the necessity for the change in criteria is not so well established that Department of Air Force should embark upon an extensive portland cement building program which would involve a substantial expenditure of money.

The observation with respect to the tax money involved, is made because of the prospective testing, and opinions expressed with regard thereto as well as upon the generally admitted fact that asphaltic concrete, in competitive bidding, results in substantially lower costs for material and installation. Therefore, we feel a period of cautious watchfulness is in order, pending these tests.

We have heard representatives of the Asphalt Industry, the Portland Cement Institute, several independent contractors and engineers, representatives of the Department of Air Force, and the Corps of Engineers, as construction agent for the Department of Air Force. The Corps of Engineers has come into agreement with the Department of Air Force that testing would be done with a view to making more accurate determinations on the suitability and adaptability of asphaltic concrete in certain areas. The situation for the moment is this:

The Corps of Engineers takes the position that now it has a design of asphaltic flexible pavement which will take the load of the B–47. That load is on the order of 100,000 pounds per square inch.

The Air Force disputes this to some extent, if not directly, at least inferentially, by pointing out alleged failures at certain fields where

increased loading and channelization of aircraft has allegedly caused breakdowns. A tabulation of these breakdowns and the cost experiences is a part of the record.

However, in the bomber dispersal program which has been adopted, the issue now presented is what may be expected and what ought to be planned for in additional load for use and operation of the B–52. That airplane has a loading factor of 250,000 pounds or nearly 2½ times that of the B–47. It is to that proposition that the attention of the subcommittee is directed.

The Corps of Engineers announced its current findings as these: That it could build the interior portion (where channelization wear and breakdown is alleged to occur) out of asphaltic concrete today. But that applying a safety factor, it would propose to extend the rigid ends of these runway pavements in portland cement an additional 500 feet over the presently accepted 1,000 feet.

Its position with respect to the taxiway, is not as clearly stated and probably not as fully accepted.

The Corps of Engineers point out that as on the end of the runways, and on taxiways, the problem is that of dealing with a fully loaded plane, whereas on the center portion of runways, the plane is partially airborne on takeoff and less heavy on landing.

But as to taxiways, it was testified that "it is conceivable that a fairly narrow rigid strip, or fairly narrow strengthened strip—at the moment we agree with them (Air Force) it should be rigid—would be capable of doing it, with the remaining widths in the flexible pavement."

The Subcommittee was advised by exchange of letters bearing date of July 31, 1957, from the Corps of Engineers, and August 2, 1957, from the Department of Air Force, that an accelerated test has been agreed to which will test the Corps of Engineers design for channelized weights on runways. The correspondence is as follows:

JULY 31, 1957.

DEAR MR. CHAIRMAN: In response to your instructions of July 8, 1957, to confer with Mr. John M. Ferry, special assistant for installations to the Secretary of the Air Force, and report back to your Committee relative to an agreed position with the Air Force on the pavement program on the interior portion of runways, I take pleasure in reporting the following:

Mr. Ferry stated the Air Force position relative to the Corps of Engineers' proposal in his letter to the Chief of Engineers dated July 30, 1957, as quoted in the paragraphs below.

"In view of the fact that we are continuing to have difficulties with asphalt pavements, we do not believe that we should adopt pavements of this material until it is conclusively demonstrated that an adequate design and adequate construction methods have been developed. Specifically, we will have paid a repair bill of approximately $10 million when the failures of asphalt pavements we know of today are repaired. To continue the use of asphalt pavements with the resultant cost to the taxpayers—in view of these facts—is not worthwhile until a more satisfactory asphalt pavement is developed. The failures of pavements, particularly on heavy bomber bases are serious in view of the fact that these critical airfields would be out of commission during the period of repair and have caused maintenance and operational difficulties in the aircraft.

"It is requested that you proceed with an accelerated test as requested by Mr. Hébert on page 844 of the hearings. We request that a portion of the runway at Columbus, Miss., designed and constructed for B–52 use, be used. The test details will be conducted as agreed during a recent conference between the Air Force engineers and General Wilson of your organization. The Air Force plans to employ one or more professional consultants to observe the performance and evaluate the results of the test so we will expect to work in close

cooperation with the Corps of Engineers during both the preliminary stages and the conduct of the field testing."

The Chief of Engineers has agreed to proceed with plans for conducting the accelerated traffic tests proposed in Mr. Ferry's letter as expeditiously as possible. I will inform your committee periodically of the progress and results of this undertaking.

Sincerely yours,

W. K. WILSON, Jr.,
Major General, United States Army, Deputy Chief of Engineers for Construction.

AUGUST 2, 1957.

DEAR MR. CHAIRMAN: This is to confirm my conversation, in your absence, with Mr. John J. Courtney, special counsel of your subcommittee, on July 30, 1957.

The Department of the Air Force has come into agreement with the Corps of Engineers, Department of the Army, for conducting an accelerated traffic test on asphalt pavement.

I am further advised that the Deputy Chief of Engineers has written to you on this matter which you will receive shortly if you have not received it to date.

Sincerely yours,

JOHN M. FERRY,
Special Assistant for Installations.

By another exchange of correspondence, the chairman has suggested that the same test include observations with respect to the adaptability of design of asphaltic concrete for channelized traffic on taxiways. That correspondence is as follows:

THURSDAY, AUGUST 8, 1957.

DEAR MR. FERRY: This will acknowledge receipt of your letter of August 2, 1957, advising the subcommittee concerning an accelerated traffic test on asphalt pavement which you have proposed and which has been agreed to by the Corps of Engineers to occur at Columbus Air Force Base, Miss.

I have also at hand a letter of Maj. Gen. W. K. Wilson, Jr., Deputy Chief of Engineers for Construction, in which a Department of the Air Force letter signed by you under date of July 30, 1957, is quoted. In the second paragraph of that quotation, I note this sentence: "We (Air Force) request that a portion of the runway at Columbus, Miss., designed and constructed for B–52 use, be used."

I want to call your attention to the fact that the subcommittee had also under consideration your proposed change in criteria for taxiways. No reason suggests itself why a test on taxiways could not also be made at the same time and place.

The subcommittee appreciates your cooperation with it and trusts that the test will be promptly completed and the conclusions evaluated before tax money is spent on any appreciable scale on specifications and bidding which exclude alternate use especially in view of the acknowledged fact that asphaltic concrete can generally be considered as substantially less in construction costs than concrete.

I trust also that the subcommittee may be advised of the times of the tests so that perhaps an opportunity might be afforded for observation by its representatives.

I am sending a copy of this letter to Major General Wilson.

Sincerely yours,

F. EDWARD HÉBERT, *Chairman.*

THURSDAY, *August 8, 1957.*

DEAR GENERAL WILSON: I thank you very much for your letter dated July 31, 1957, on the proposed test of asphaltic-concrete design prepared by the Corps of Engineers to be tested at Columbus Air Force Base, Miss.

I am enclosing a copy of my letter to the Department of the Air Force on this subject for your information and such advice as you may care to give thereon.

The subcommittee is very appreciative of your prompt action in this matter and await the conclusion of the tests for your further advice.

Your undertaking to keep the subcommittee advised periodically is greatly appreciated in the public interest.

Sincerely yours,

F. EDWARD HÉBERT, *Chairman.*

By far the greater volume of material, and therefore the greater cost, is involved in the runways.

With this statement of our position and these observations with respect to the testimony thus far, the subcommittee makes this interim report and announcement of the text for scientific and technical conclusions. Pending this determination, we repeat the caution previously expressed concerning any extensive Air Force building program, excluding the less costly material and design alternate.

When the hearings resume to consider facts developed in the testing, the subcommittee will also consider Navy Department criteria for its airstrip paving requirements. For the moment, the problem of the Navy does not appear to be as critical nor of the magnitude of the Air Force problem.

Approved unanimously by the subcommittee, August 14, 1957; ordered printed and published.

F. EDWARD HÉBERT,
Chairman, Subcommittee for Special Investigations.

Approved: August 14, 1957.

CARL VINSON,
Chairman, Armed Services Committee.

AIRSTRIP PAVING MATERIALS

MONDAY, JUNE 24, 1957

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE FOR SPECIAL INVESTIGATIONS,
Washington, D. C.

The subcommittee met at 10 a. m., the Honorable F. Edward Hébert, chairman of the subcommittee, presiding, with the following members present: Mr. Hess, Mr. Rivers, Mr. Gavin, Mr. Fisher, Mr. Cunningham, Mr. Hardy, Mr. Bates, and Mr. Miller.

Mr. HÉBERT. The committee will be in order.

Members of the committee, the chairman desires to make the usual opening statement at this particular time.

Early in 1954, under the chairmanship of my colleague, William E. Hess, of Ohio, this subcommittee of the 83d Congress conducted an inquiry into a premium of 5 percent given concrete pavement over asphalt pavement on airstrip runways.

At the conclusion of those hearings the subcommittee found that there was no evidence to justify that preference.

On August 16, 1954, the Department of the Air Force discontinued the 5 percent differential and advised the subcommittee that:

> This is to inform you that we have completed a review of all available information from the field which has a bearing on the subject. While we are completely convinced that 100 percent concrete paving has a definite advantage as compared to a combination of concrete in the critical areas and asphalt in the noncritical areas, we have been unable to collect engineering backup, as reflected by maintenance costs, to substantiate this view * * *. We have, therefore, suspended premium payments for cement concrete in noncritical runways.

That part of the paragraph with the sentence:

> We have been unable to collect engineering backup, as reflected by maintenance costs, to substantiate this view,

has been underscored by myself.

But the matter was not to rest there. The Department of Defense invited the Highway Research Board and the National Research Council to conduct a survey of 27 military airbases to determine "the effects of military aircraft on airfield pavements." I may observe that generally there has been agreement that concrete might be used exclusively in areas subjected to heat, blast, and fuel spillage.

Our inquiries therefore have centered upon the alternate use based upon price competition of asphaltic concrete against cement on the runway areas, which, of course, comprise the greater volume of material. As to those areas, this research group found and reported to the Department of Defense that the differential in construction of these two "is frequently sufficiently great to justify the use of less

costly type in those noncritical areas where it is adequate and satisfactory."

Some time in 1955 cement was ordered exclusively on all "primary taxiways." This proposal was incorporated in the fiscal year 1956 Air Force program; but it was proposed to be done "pending completion of tests."

On February 1956 the Chief of Air Installations advised the Appropriations subcommittee on air paving that the Air Force was "essentially operating a concrete paving program especially in the United States.

During the course of 1956, so far as the subcommittee is informed, substantially all of the previously established competitive criteria were abolished and for all practical purposes cement has been approved exclusively, notwithstanding the initial cost.

Naturally, the protests have mounted. Congress, of course, is concerned with what is admittedly a substantial price differential between asphalt concrete and portland cement in competition; and Congress is concerned, and this subcommittee is concerned with this decision particularly, not only because of excessive cost but because of the rapidly changing techniques and requirements of the military weapons system. Therefore, we propose to spread upon the record all views relating to the choice to be made in a controversy of this kind where so much money is involved in the ultimate decision.

It is not a decision that ought to be arrived at in secret. It is of vast importance to our economy and to an understanding of our military requirements that the whole subject be brought into the open and all factors weighed impartially.

With that in mind, we will hear from the Department of the Air Force on its requirements, present and projected. We will hear from the military departments and their branches on their experiences and conclusions; and we will hear from industry, suppliers, and contractors generally on their views concerning the proper choice to be made in the light of requirements and the availability and costs of materials.

First witnesses will come from the Department of Air Force. A list has been supplied to the interested parties and to the press. And we will continue with this hearing day by day until all witnesses have been heard and until the entire problem has been threshed out in the open and made a part of the public record, in order that the American public might be informed of the position of all parties on both sides of this controversial question.

Mr. Courtney, call your first witness.

Mr. COURTNEY. Mr. Chairman, Mr. John M. Ferry, special assistant to installations of the Department of Air Force, representing the Secretary's office. Mr. Ferry is known to the subcommittee. I have given to the press a statement of his official position. Mr. Ferry, I believe you have a prepared statement?

TESTIMONY OF JOHN M. FERRY, SPECIAL ASSISTANT TO INSTALLATIONS, DEPARTMENT OF THE AIR FORCE; ACCOMPANIED BY GEN. AUGUSTUS MINTON, ASSISTANT CHIEF OF STAFF, INSTALLATIONS; COL. W. D. ALEXANDER, CHIEF, ENGINEERING BRANCH, DIRECTORATE OF CONSTRUCTION, AND COL. ROBERT R. CONNER, DIRECTOR OF CONSTRUCTION, ASSISTANT CHIEF OF STAFF, INSTALLATIONS

Mr. FERRY. I have, Mr. Courtney. With the permission of the chairman, I would like to read this prepared statement, which effectively presents the views of the Air Force from an official point of view. With your permission, Mr. Hébert?

Mr. HÉBERT. You may proceed in that manner, Mr. Ferry. And I may suggest to the subcommittee, in order to expedite the matter, that they allow you to finish your complete statement, and make notes as to the questions they would like to ask you, after you have completed. So I will ask the cooperation of the subcommittee in that respect. You may proceed, Mr. Ferry.

Mr. FERRY. Mr. Chairman, and gentlemen, in preparing this statement to your subcommittee, I have been guided by the letter of May 4, 1957, signed by Mr. John J. Courtney, special counsel, which delineated six major items of particular interest to you.

In presenting this information, I find it desirable to make a few general comments. We are prepared to give as much detailed information as the committee may care to hear and I have here a group of engineers and technical people ready to cite specific examples and experience.

At the time of the 1954 hearings before your committee, you will recall that one of the major problems facing us was that of design, construction and maintenance of satisfactory pavements from which modern military aircraft could be operated regularly for a reasonable length of time. This problem still faces us today, in fact, it has been rapidly increasing in severity as development of aircraft has progressed.

Consider the cost, in idle facility, equipment and personnel which results if a runway pavement fails and the operations must be shut down or temporarily relocated while repairs are being made.

Some idea of its importance can be gained if we consider a single typical airfield, i. e., March Air Force Base. We have a total facility costing over $58 million to support $258 million worth of aircraft with a complement of over 9,000 military and civilian personnel. I might note that the pavement at this base did fail and such an interference with operations did, in fact, take place. This was inconvenient and costly, but it would have a more important and far-reaching effect if this base were inoperative at a critical time of world crisis. From any point of view, we simply cannot afford to have marginal pavements jeopardize the Air Force mission in face of the potential threat of enemy action which can become a real threat within only a few hours' notice.

In order to understand what is happening, we should recognize that during the past few years, the development of military aircraft has been phenomenal. Plane weights have increased with cor-

responding increase of unit loads on pavements, and the airplane tire inflation pressures have also been raised. These factors, of course, increase the severity of the effect of the aircraft upon pavements. The most modern aircraft have landing gears so arranged that the wheels (single or dual) trail each other successively—the tandem arrangement. This results in confining the pavement loadings to a relatively narrow width, longitudinally. This fact, coupled with the ability to operate along the center of the runway and taxiway by virtue of improvements to the planes, has developed what we call channelized traffic, that is, a concentration of wheel loadings over a relatively narrow width of pavement. Experience with this type of pavement loading is showing that the effect upon the life of the pavement is severe, far beyond our experience earlier with earlier airplanes.

As these various aircraft characteristics have developed, our problems of providing satisfactory pavements which would give a reasonable service life have increased in direct proportion. To compensate for the increased loadings, heavier pavement structures are required. This is, of course, more costly.

Experience has shown that pavements which were satisfactory for the aircraft a few years ago are showing major distress today. Indeed, since the 1954 hearings before your subcommittee, there have been reported an alarming number of major failures in pavements.

I would like to emphasize my next sentence. While rigid pavements are not free from problems, it is observed that there are many more cases of pavements of the flexible type which show the effects of channelized traffic of heavy wheel loads to a very serious degree.

Of the bituminous pavements constructed since 1950 for light-load duty (25,000-pound wheel loads on 200 pounds per square inch tires), and heavy-load duty (100,000-pound gear loads on 200 pounds per square inch tires), 47 have had major repairs or replacement for the following reasons:

(*a*) Taxiways and runways have been repaired and in some cases replaced because of the effects of channelized traffic of heavy aircraft.

(*b*) Bituminous runway ends have been replaced with like capacity concrete pavements because of jet-engine heat-blast damage.

(*c*) Jet fuel resistant seal costs have been applied to bituminous pavements in areas used for parking and servicing of jet aircraft to reduce the solvating effect of spillage of jet fuels and other petroleum derivatives.

(*d*) Asphaltic pavements have been overlaid with tar-rubber surfaces to repair effects of fuel spillage and to prevent or reduce further damage.

You will recall that at the conclusion of the 1954 hearings the recommendation was made and followed by us, that flexible and rigid pavement construction be placed on an equal competitive bidding basis, except for certain areas which it was concluded were most susceptible to damage because of heat, blast, and spillage effects. The rapid development of the severe effects of aircraft mentioned previously has resulted in two major changes in Air Force criteria since that time.

Namely, the requirement for rigid paving in channelized areas and in all primary use pavements.

The term "primary use pavements" is defined as:

(1) All paving areas on which aircraft are regularly parked, serviced, and maintained on preflight check;

(2) All runways having length, width, and approaches to permit sustained use by combat or combat-support aircraft;

(3) Taxiways connected to paved areas defined above.

These criteria have been based upon research and professional engineering judgment, which were exercised in attempting to find reasonable solutions to the increasingly severe deterioration of pavements.

Accordingly, at the present time, with the approval of the Secretary of Defense and the knowledge of your subcommittee, portland cement concrete is specified for all primary use airfield pavements in support of combat or combat-support type military aircraft.

Primary use pavements include aprons, taxiways, warmup pads, runways, calibration hardstands, washracks, and jet-engine runup areas.

The Air Force does, however, specify asphaltic concrete for blast pads and stabilizing shoulders of aprons, taxiways—a word has been omitted in the statement, gentlemen—secondary taxiways and 200-foot-wide runways, as well as for roads within the base area.

There have been, and will undoubtedly continue to be, exceptions to the basic policy where dictated by particular conditions. But, I repeat, these changes have been brought about by our experience with failures of flexible pavements. We have and are continuing to watch the service behavior of our airfield pavements, and the results of surveys from a large number of airbases are used as a basis for determining the adequate type pavement required to support our mission.

I might note here that through our design and construction agency, we have conducted research and actual testing in an attempt to find a flexible pavement design which would produce a pavement which would withstand these modern loadings, but so far without success. In fact, all tests demonstrated the superiority of the rigid pavements.

The recent changes in pavement criteria require closer tolerances in smoothness criteria, greater total thickness, more compactive effort, closer control of the gradation of base course aggregate, and of the aggregates used in the asphaltic concrete. While flexible paving is still cheaper than rigid, these factors have tended to increase the cost of flexible concrete pavements. The following table showing quantities and costs for both types of paving will illustrate this statement.

I ask that be included in the record, without reading the figure.

Mr. HÉBERT. It will be included.

(The table is as follows:)

Heavy load rigid pavements

Period	Square yards	Total cost	Unit cost
February to October 1952	3,287,212	$23,500,000	$7.14
October 1952 to May 1953	2,463,631	17,600,000	7.15
May 1953 to July 1954	7,573,209	53,500,000	7.07
July 1954 to December 1955	13,277,974	88,400,000	6.66
Total	26,602,026	183,000,000	6.89
December 1955 to March 1956	2,507,914	19,100,000	7.60
March 1956 to April 1957	7,054,744	53,400,000	7.57
Total	9,562,658	72,500,000	7.58

Heavy load flexible pavements

Period	Square yards	Total cost	Unit cost
February to October 1952	1,046,107	$5,300,000	$5.09
October 1952 to May 1953	1,912,315	6,200,000	3.26
May 1953 to July 1954	3,340,439	12,600,000	3.77
July 1954 to December 1955	8,210,360	29,200,000	3.56—
Total	14,509,221	53,300,000	3.67
December 1955 to March 1956	1,169,695	6,300,000	5.40
March 1956 to April 1957	247,996	2,300,000	9.40
Total	1,417,691	8,600,000	6.08

Mr. FERRY. Since December 1955, the average cost of heavy duty rigid pavement has been $7.58 per square yard while the average cost of heavy duty flexible pavement has been $6.08. The latter cost reflects two unusual jobs, one at Minot, S. Dak., and one at Eielson AFB, Alaska, which increased the cost of flexible pavement. The percentage increase in cost of rigid pavement since 1955 is approximately 9 percent whereas the percentage increase for flexible pavement has been approximately 30 percent.

The new heavier load bearing designs have not been in use long enough to establish a comprehensive determination of the overall increase in paving cost when both first cost and annual maintenance expense are taken into consideration. The indications are, insofar as we have been able to observe, that in the long run the rigid paving will be no more expensive and certainly far more satisfactory in performance than any flexible paving designed to date.

In conclusions I should like to repeat: modern heavy bombers have forced us to increase our heavy loading criteria from 100,000 pounds on dual wheels 240,000 pounds on twin-twin gear and design for load passes up to 30,000 or an estimated 20 years of life. Also, due to the gear configurations and balance of the aircraft, we must require pavements to be more accurately controlled with respect to grade and surface smoothness. To amplify this, I call attention to the complex navigation, communication, and bombing equipment, largely electronic, using relatively delicate amplifying tubes now an essential part of both bombers and fighters.

During the takeoff and landing runs, if the paving is not smooth and fairly level, the planes start to sway up and down, what we call porpoising which can and does knock tubes out of operation and incapacitates these essential parts of the plane equipment.

In closing, I am most anxious the committee have full assurance that the Air Force attitude on pavement design is not the result of prejudice, or arbitrary decision on the part of any person or group involved in formulating design.

We believe it to be a well considered position, arrived at over a long period of study and based on experience and engineering judgment. It is a position we are firmly convinced will operate in the best interests of the Air Force and of the United States Government.

And I have attached hereto a list of the Air Force bases at which major repairs and replacement of asphaltic concrete or overlays have been accomplished.

(The list is as follows:)

List of Air Force bases at which major repairs and replacement of asphaltic concrete has been accomplished

Repairs channelized traffic	Replacement channelized traffic	Bituminous R/W ends replaced	JFR sealcoat bit-pavement jet fuel spige	Tar rubber overlay on bit-pavement
Pinecastle	Davis-Monthan	Davis-Monthan	Oxnard	Presque Isle
McDill		Homestead	Selfridge	Dow
Castle		Pinecastle	Hunter	Ellsworth
Mountain Home		Benguerir	Loring	Travis
Walker		Boulhaut	Mountain Home	Biggs
Biggs		Wheelus	Travis	McDill
Fairchild		Nouasseur	March	Lajes
March		Kindley	Biggs	Andrews
		Dover	Dow	
		Truax	Ardmore	
		Sidi Slimane	Webb	
		Altus	Williams	
			Scott	
			Andrews	
			Dover	
			Palmbeach	
			Eielson	
			Ladd	

Mr. FERRY. I am at your disposal, gentlemen, and will attempt to answer with reasonable intelligence any questions you may care to address to me.

Mr. HÉBERT. Thank you very much, Mr. Ferry. There are just 1 or 2 questions I would like to ask.

At the top of page 3 in which you refer to the major failures in pavements and then say:

> while rigid pavements are not free from problems it is observed that there are many more cases of pavements of a flexible type which show the effects of channelized traffic of heavy wheel loads to a very serious degree.

The failure of your paving in areas which are called critical is greater than in the areas where the asphalt, the flexible paving covering, was used in the noncritical areas, do I understand that to be your statement?

Mr. FERRY. That was not my intent to convey, sir. What I was trying to say: In critical areas where we have had asphaltic concrete as compared with the portland cement concrete, the frequency of trouble with the asphaltic concrete has been far greater than with the portland cement concrete.

Mr. HÉBERT. The point that I would like for you to elaborate on and explore for the committee is the net failure—in other words, if you are making a comparison between the failure of the flexible and the nonflexible covering, do your failures occur in proportion to your critical areas, as compared to the failures on your noncritical areas?

In other words, the failures of asphalt that you described. Are they confined to noncritical or critical areas?

Mr. FERRY. They are not confined, sir, but the effect has been apparent to us and troublesome to us in the critical areas. I would like to elaborate on that at your suggestion, particularly in taxiways, where the planes are communicating in a relatively narrow channel between the parking areas, parking servicing areas, and the runway ends.

We have found there a very serious deterioration of flexible type taxiways with channelized traffic.

Mr. HÉBERT. You have not found that where you use the concrete or the portland cement?

Mr. FERRY. We have had trouble, sir, where we have used concrete, but the frequency of the trouble has been far less with the concrete runways—taxiways.

Mr. HÉBERT. I am sure the members will explore that further. I just wanted that in the record.

Mr. FERRY. Right.

Mr. HÉBERT. There is just one other comment I wanted to make The term "primary use pavements": You don't leave anything out of primary-use pavements, do you?

Mr. FERRY. No.

To be truthful, we are with you. We consider all of our runways to be primary use pavements. There are such things as out to a hardstand, perhaps.

Mr. HÉBERT. So in reality you are making everything critical and the use of the word "primary use pavements" does not indicate that there are other areas where you have any appreciable amount of asphalt covering.

Mr. FERRY. I think that is a fair statement, sir.

Mr. HÉBERT. It could have really been left out, so we would know what we are talking about.

Mr. FERRY. Except I do want to bring out that we do it on secondary taxiways, and on roads——

Mr. HÉBERT. Which are unnecessary.

Mr. FERRY. The road feature is not negligible, sir. We have quite a bit of roads on an airbase.

Mr. HÉBERT. Yes, but we are not talking about transportation roads. We are talking about roads used for aircraft. We want to get it very clear what we are talking about, and not have any misleading language in here, which I am sure it is not your intent.

Mr. FERRY. Yes, sir.

Mr. HÉBERT. And in the next paragraph I want to clear up another thing. You say:

> Accordingly, at the present time, with the approval of the Secretary of Defense and the knowledge of your subcommittee, portland cement is specified for all primary use airfield pavements in support of combat or combat support type military aircraft.

I am sure you do not want to leave the impression in that statement, in indicating that this was done with the knowledge of the committee, that it had the approbation or approval of the committee.

Mr. FERRY. No, sir; I do not want to convey that intention at all.

Mr. HÉBERT. As a matter of fact, the committee had nothing to say about it, and the committee was not consulted on it, and the committee was merely told of the change in criteria following its agreement of the committee under Mr. Hess' jurisdiction.

Mr. FERRY. I have to agree, sir.

Mr. HÉBERT. That is right, sir. We understand that you don't intend by the use of the words "knowledge of your subcommittee" to indicate that we agreed on anything you did.

Mr. FERRY. I do not, sir.

Mr. HESS. Mr. Ferry, I would like to refer to page 5 of your prepared statement and some of the figures which you set out there. Of

course, the previous hearings were held in early 1954, and the report was made, I think, in the spring of 1954, the report by this committee.

I note there that the unit cost of heavy load rigid pavements began to drop from July 1954 to December 1955, and it dropped considerably, from $7.07 a unit to $6.66 a unit. Do you think that probably the committee action had any bearing on that?

Mr. FERRY. I would doubt it, Mr. Hess. I think it was just at that time a condition of the contracting market, that the fellows were hungrier for work.

Mr. HESS. I note also at about that same time that the heavy load flexible pavements were dropping, but not in the same amount. There was just a small drop there.

Then I note a little further down that the flexible pavement from March 1956 to April 1957 has increased to $9.40 unit cost, which is almost $2 in excess of the unit cost for heavy load rigid pavement.

Mr. FERRY. I explained that, sir, in my subparagraph below. I wanted to specifically, in order that you would have all the facts that are available, to say that these were built at a very high cost in a difficult construction area. Frankly, I don't think those are typical or representative of modern flexible type paving, but were the only figures we had to fill out this record.

They were built in Alaska and at Minot, N. Dak., where weather conditions and the working conditions—you have a short season—made for an expensive and costly type of airfield construction, either asphaltic or concrete.

Mr. HESS. If those two bases were eliminated it would probably give a clearer picture of the unit cost.

Mr. FERRY. I think so. Those were the only figures we had of new paving that we could put to you.

Mr. HESS. They were the only figures?

Mr. FERRY. That is right.

Mr. HESS. I note also now the average of the flexible against the rigid there is about a 20 percent differential.

Mr. FERRY. That is our latest figure.

Mr. HESS. That differential has increased since the hearing in 1954, hasn't it?

Mr. FERRY. Yes, sir; it has.

Mr. HESS. I believe it was 10 percent at that time.

Mr. FERRY. It was.

Mr. HESS. I think that is all.

Mr. RIVERS. Mr. Ferry, in your statement you mentioned the fact that SAC planes—and we are primarily dealing with SAC statistics. Because I noted the bases you give here are practically—every one I recognize is a SAC base.

Mr. FERRY. Many of them, sir.

Mr. RIVERS. These two-hundred-thousand-odd wheel loads: Where you build the rigid runways, it follows that the thickness—I meant to say the nonrigid runways, or the flexible runways, where you build them, have to be thicker. Just like the highways we see built out here all over the place.

Mr. FERRY. Yes.

Mr. RIVERS. In my part of the world we don't build any concrete highways. And you know we have the best roads in the United

States. We don't even have a speed limit. We have a minimum limit. You can't even drive less than 40 miles an hour in my country. All of our roads are made of asphalt.

But I noticed down where I come from we have to continuously build them thicker and thicker.

Mr. FERRY. Yes.

Mr. RIVERS. It even takes longer to build them. It takes much longer to build a highway in my country than it used to, when they built them out of concrete. They flatten them out and pour the concrete and go on out about their business.

Now, they put the thing down, roll it, plow it up again and roll it, and do that forever. It looks like the old WPA project, where they swept up leaves and then spread them out again.

Mr. FERRY. Mr. Rivers, it stimulated a thought.

Mr. RIVERS. Yes.

Mr. FERRY. That the wear on a pavement is dependent not only on the weights which are placed upon it, but the frequency with which this weight goes over the road.

So in your case, there you are getting heavier trucks than you used to have, and you are getting heavier traffic surely, as the years go by, the same as we have in airfield pavements.

Mr. RIVERS. In a flexible runway, you say the longevity of a rigid runway naturally is longer, that is, the life of it is longer. But I notice Mr. Hess brought out there the unit cost of the heavy duty flexible is just about a dollar and a half less than the rigid.

Mr. FERRY. That is right, sir.

Mr. RIVERS. About $1.50 less.

Mr. FERRY. Yes.

Mr. RIVERS. And that thing approximates more and more as you go along, the heavy duty flexible as against the heavy duty rigid.

Mr. FERRY. There will always be a differential in my judgment in favor of the flexible.

Mr. RIVERS. Coming back to your statement, as a result of that cost plus the maintenance and the longevity over a given number of years on a given runway, which would be the cheaper?

Mr. FERRY. I wish I had figures to substantiate what I am about to say. I do not have the figures. All I can say is that it is the best judgment based upon relatively short experience with these heavier airplanes, that the cheaper long-run result, both in dollars and in satisfaction, will be with the rigid paving.

Mr. RIVERS. Now you talk about the porpoising. I live in a country where they have porpoises. They are always going down and coming up like this [indicating]. Is it possible to build a flexible runway that doesn't have the porpoise characteristics in it?

Mr. FERRY. Yes, sir; but it is difficult. It can done.

Mr. RIVERS. I never saw it. But you can build a rigid one that does not have it?

Mr. FERRY. We can, sir; it is simpler to do it with concrete.

Mr. RIVERS. But it is just about impossible to build one?

Mr. FERRY. No, sir; you can do it. It means very careful control, very good inspectors in the field—it can be done.

Mr. RIVERS. I have seen Sidi Slimane and I have seen Nouasseur, which you have here——

Mr. FERRY. We don't find it very often, but it can be done, Mr. Rivers. I am trying to be completely objective in my conversations with the committee. It is possible.

Mr. RIVERS. I want to ask you this. Since we have this other concept of dispersal which makes all airbases available to SAC planes, you are going to have to come to 1 of 2 conclusions. You are going to either have to build all like you are building these SAC bases or do without the dispersal if you don't use more concrete?

Mr. FERRY. Mr. Rivers, you put your finger upon the very essential heart of our thinking today. The Air Force is by the very nature of its requirements completely flexible and must have the ability to put our heavy planes down at any place in time of war.

Mr. RIVERS. At our field at Charleston, we extend the runways now about 3,000 feet, or our 7,000-foot runway, and it presents quite a problem to extend it. Now, that has the critical ends paved, because we have an ADC unit there.

Mr. FERRY. Yes, sir.

Mr. RIVERS. The critical ends are paved. The taxiways aren't paved.

Mr. FERRY. Yes.

Mr. RIVERS. Neither are the parking aprons paved. Because it is a MATS base.

Mr. FERRY. Yes.

Mr. RIVERS. When you get to that extending thing, and when you disperse planes from down in Hunter, Ga., or some other SAC base, then you are confronted with another problem, under your testimony.

Mr. FERRY. Yes.

Mr. RIVERS. It looks like to me we are getting to the point now where if we are going to use flexible runways for these increasingly heavy planes, one of these days, the costs are going to run into each other and cross.

Mr. FERRY. I wish we had an answer to that, sir, but I have no figures to show it. All I say is that we have not yet been able to design a flexible paving which will take over a long period of time these heavy wheel loads. We don't know—I don't know how to do it, nor do my people.

Mr. GAVIN. At that point will the gentleman yield?

Mr. RIVERS. Yes. I have one other question.

Mr. GAVIN. I just wanted you to yield at that point.

Mr. HÉBERT. Go ahead, Mr. Gavin.

Mr. GAVIN. What progress is being made on your studies on this flexible pavement to develop a technique whereby you can develop a flexible pavement to withstand the continuous traffic of heavy aircraft like the B–52's? What progress are you making on that?

Mr. FERRY. We are making progress with the Corps of Engineers, as our design and constructing agency and our advisers on technical progress. They have a laboratory out at Vicksburg where they are running a series of tests on a number of combinations and designs of both concrete and asphaltic pavings, with and without reinforcing it.

They are constantly working with a group of very competent people indeed—believe me when I tell you this—to try to develop an asphaltic pavement that will stand up.

I refer now to what is commonly known in this controversy as the Kelly test, where we built a concrete and an asphalt test strip to the best design that we knew how to do for both, and we ran a simulated test across there by pulling a loaded truck having B–52 wheels on it with a tractor. We pulled it back and forth. We built both the concrete and the asphalt in a continuous strip, in order that they would have the same test conditions. It was built the best way we knew how. But unfortunately the asphaltic did not stand up in a satisfactory condition. The concrete did.

Mr. RIVERS. It looks to me like regardless of our feeling for the economies at the moment, the claims of the asphalt industry—and I have refineries in my town and they are building another one—that if the asphalt can't meet the competitive long-range tests, it has no business there.

Mr. FERRY. Mr. Rivers, I believe they might be able to do it.

Mr. RIVERS. I don't know about that. I am just talking about it. But if they can meet it, they have their place under the sun. But if you are going to keep on building planes so heavy that the maintenance of asphalt—it is more subject to the elements than anything else. There is nothing else on earth hotter than a hot asphalt runway. I don't care what they say. I have been on both of them. I can't give you any analogy, but I will give it to you afterward.

If they can't stand the elements with the wear and tear of the terrific per unit weights, they have no business there. And if they can't stand it over the years, as against 20 years, without constantly maintaining them, they have no business there.

I am finished.

Mr. FERRY. Mr. Rivers, you and I see eye to eye on this matter.

Mr. GAVIN. In this test you are talking about, you are talking about now the strength of the runways and what they will stand. What kind of test have you when a B–52 comes in for a landing, and that is the impact when it hits that concrete or hits that asphalt? How are you approaching that angle of it?

Mr. FERRY. Curiously enough, Mr. Gavin—and this is something I think that is not too well known—the heaviest load is when the plane is rolling on ground, rather than the impact when it is coming in. When it is coming in it is partially airborne. Part of the weight is being carried by the wings. The real heavy part of this job is when they just roll in on the ground.

Mr. GAVIN. Yes; but supposing you are in an area where you have terrific heat, the climate affects it and the asphalt is soft. I am a layman. I am just listening now. I was wondering—they are coming in for a landing now on soft pavement. What is the impact when it hits asphalt under terrific heat?

Mr. FERRY. The asphalt industry has developed a high-temperature asphalt that stands up, as far as temperature is concerned, reasonably well.

Mr. GAVIN. Is that so?

Mr. FERRY. You get skid marks, sure, but I mean it is not primary damage.

Mr. GAVIN. Is that so? It is interesting.

Mr. RIVERS. Would the gentleman yield right there?

Mr. GAVIN. I will yield.

Mr. RIVERS. You mean to say that they have an asphalt runway that is just as resistant to heat as concrete?

Mr. FERRY. No, sir; I didn't say that. I said that it could stand up with the high-temperature asphalt, which the asphalt industry has developed—it stands up quite well under the normal sun temperatures.

Mr. FISHER. Mr. Chairman, as usual, I will be very brief with mine.

Mr. HÉBERT. You set a good example, Mr. Fisher.

Mr. FISHER. I was interested in Mr. Rivers' questions and the subject he explored there. It is something that I had in mind going into a little bit.

You put a great deal of emphasis on the weight situation that has developed with modern aircraft—the B–52's, 47's, and so forth.

Mr. FERRY. Yes.

Mr. FISHER. As one of the reasons for the rigid-type airways being preferable to meet that weight situation.

I was going to ask you if in view of that there isn't some area there for extension between the requirements in SAC and in the Air Training Command, for example, for the runways? In other words, could you develop a different criteria for the planes that use them that have less weight than with the big ones?

Then, of course, you spoke of a dispersal program, which may be your answer to that. Is that correct?

Mr. FERRY. It is in part an answer to it, sir.

Were we building a base that was a pure training base and it would be used for nothing but light planes, I think we would design asphaltic concrete down there, were it not for the fact that we today with this business of SAC dispersal are moving planes by squadron all over the United States—not only the 52's but the wings of B–47's—in a process of great flux of assignment of Air Force planes today. And frankly, I think it is a mistake to assume that you would build any new base today that doesn't have the versatility to take anything.

Mr. GAVIN. Doesn't have the virtue of what?

Mr. FERRY. Have the versatility to take anything.

Mr. FISHER. And that is your practice at this time, or your policy?

Mr. FERRY. Yes, sir.

Mr. FISHER. If you build a new airstrip or new pavement for Air Training Command, to do ordinary training in jet training planes, you use basically about the same type of paving you would in a heavy SAC base; is that correct?

Mr. FERRY. Except for this difference, sir, that I would design it for 100,000 wheel load on twin wheels rather than 240,000 pavement on dual wheels or tandem wings. Because I point out as I pointed out before, it is not only the weight but the frequency with which it is imposed. Hence, if it were not going to be regularly used by heavy planes, the 100,000 pound pavement is probably sufficiently heavy and more economical.

Mr. FISHER. That is all, Mr. Chairman.

Mr. CUNNINGHAM. Mr. Chairman, I would like to ask Mr. Ferry a question or two.

Some 3 or 4 years ago before Mr. Rivers' subcommittee, the Air Force, as I recall, came up and asked for approval authority to extend the runway at the Offutt Air Force Base at Omaha, and also to strengthen it.

Mr. FERRY. Yes.

Mr. CUNNINGHAM. The reason given was that a service plane or defense plane landed there—I believe it was an emergency landing. While taxiing down the runway, the wheel dropped through or lowered on the runway, the plane tipped over and caught fire and every serviceman on there was burned to death.

With that thought in mind, I wonder if the cost factor shouldn't be considered in the value of lives? Our primary purpose here is to save lives and save valuable material. As I see it, there is no second best for the serviceman.

I don't recall whether the testimony showed that that runway where the wheel dropped through was asphalt or cement. My recollection is—my impression is that it was cement. I wonder if you have any figures to show the actual serious accidents on the airfields throughout the country, a comparison with the amount of asphalt runways and the amount of cement runways, what the percentagewise in relation to the amount of serious accidents has been, and also whether or not when you get into this heat and cold question there are any figures to show the difference between accidents on a cement runway or airfield and an asphalt one, if you have them, in the islands and in the cold countries like Alaska.

I wonder if we have that information available.

Mr. FERRY. I do not have it available, Mr. Cunningham. It is possibly in our air safety records branch that such a breakout might be made, though I do not know of its existence today.

Mr. CUNNINGHAM. I recall—this was a good many years ago, some 25 or 30 years ago, in driving over the continental divide in Colorado, it was all gravel. You get up so high, there was no concrete and there was no asphalt. In asking a question why didn't they asphalt it up there, they said, "In months in the summertime it got so hot, if they had to asphalt it it would run and buckle up." I received the same information once when I was chairman of the roads committee. I went over the Alcan Highway. That is why it wasn't used there. Of course, they said cement couldn't be used at all up there. I just wonder if we are getting to the bottom of this from the standpoint of what will save the most number of lives for the servicemen and be the best for the country. I don't think it is a question of cost between one and the other primarily. I think the primary objective that this committee has is to save lives of American servicemen particularly.

Mr. FERRY. Mr. Cunningham, I much appreciate the expression of your feeling on that. Though I do not have any figures which I could present, I will attempt to develop it.

Mr. CUNNINGHAM. Let me give you one observation which is pretty old. This again goes back 20 years. I happen to live in a town where we have one or more cement factories and also quite an asphalt industry. And it has been a running fight as long as I can remember in that town since they had various kinds of pavement. For many years, and I think probably yet, there is as much asphalt paving in the city as there is concrete. Now this is my personal observation. After a real hard winter, for a month or 6 weeks, having below freezing and lots of snow, and it melts, apparently there are holes from 1 to 2 and 3 feet in diameter all over the city, and the asphalt would just disap-

pear. It would disintegrate. There is damage also to the cement, but not the same way.

Mr. FERRY. Yes.

Mr. CUNNINGHAM. Now have you had those experiences.

Mr. FERRY. That is exactly our experience, sir. We find that we have far more maintenance and far more problems of disintegration of the flexible type pavement.

Mr. CUNNINGHAM. Now, I want to say in fairness to the asphalt industry this was some years ago and they probably have perfected their product so those things don't happen today, I don't know.

Mr. FERRY. I point out to you today in talking about the effect of heat on asphaltic pavement, that the asphaltic institute have done a very good job of developing a high temperature asphalt that does not run like the old asphalt, or what we called tar pavements years ago.

Mr. CUNNINGHAM. But they have one now where it won't run, say in 100-degree heat, or 95?

Mr. FERRY. Actually, sir, at this Kelly test, we took temperatures there of 140 degrees on the surface of the asphaltic and concrete runways. There was a little softening, but it didn't run. It was a little soft, but it wasn't bad.

Mr. CUNNINGHAM. Now as a matter of fact, cement doesn't run at all, does it?

Mr. FERRY. Not at all.

Mr. HARDY. Mr. Chairman, the thing that bothers me about the kind of testimony we are getting from Mr. Ferry is that it strikes me to be a rather unengineering approach.

Now, Mr. Ferry has given us a lot of information which may be perfectly valid, but apparently they based all the decisions on judgment rather than on any development of fact.

Now a question was just raised by Mr. Cunningham. Mr. Ferry, as I understand it, said we have had far more failures and far more problems with the flexible paving than we have with the rigid.

Well, now, I think if that is the case—I understood you to say that, Mr. Ferry.

Mr. FERRY. Yes.

Mr. HARDY. If that is the case, there ought to be some figures to back it up.

Now I haven't seen any figures to back that up, and I notice that on page 3 of your statement—Mr. Hébert referred to it earlier—in the first paragraph that is complete on that page you said, "Of the bituminous pavements constructed since 1950"—and I will skip your parenthetical statement in there—"47 have had major repairs or replacements for the following reasons."

Well, you don't make any comparison with your rigid pavements that were constructed during the same period and to essentially the same type of specifications, and without some comparisons this thing doesn't mean anything to me.

Mr. FERRY. Mr. Hardy, I could have given a long engineering dissertation, but I felt it was probably more of general use to have given general comments, as I said in the beginning.

Mr. HARDY. But when you make a statement like that, and when in response to questions that have been raised by other members of the committee the only thing you say is, "this is our judgment; we don't

have the facts," and you made that statement I'll bet a half dozen times during your testimony here this morning.

Mr. FERRY. I don't think I said, Mr. Hardy, we do not have the facts. I said we do not have the cost figures on the cost of maintenance of fields. I have behind me here a group of engineering officers who are familiar with this, who have data which we can produce to you.

Mr. HARDY. Let me say this to you. If you have facts to back up your position, I am perfectly willing to go along with you. But I haven't seen any evidence of them. And, as a matter of fact, the information that we had here previously—it seems to me the factual presentation was in favor of asphaltic concrete rather than in favor of your rigid concrete. I don't know which is which. But when you come up here with generalities and make decisions based on judgments without engineering support of it, I get suspicious of what is back of it.

Mr. FERRY. I would understand thoroughly if that were the case, Mr. Hardy. But that is not the case. We in the Air Force made a very careful survey of our airfields all over the world, with reports and photographs of the conditions, which we have available for the use of the committee. That has been going on now ever since the hearings in 1954, because I realize we needed more and additional data to convince the committee of our views.

Mr. HARDY. Do you have an objective comparative set of photographs that relate both to rigid and flexible pavements?

Mr. FERRY. Yes, Mr. Hardy; both. It is completely objective.

Mr. HARDY. You spoke awhile ago of a test strip that was laid, part asphalt and part portland. Do you have any clear analysis of the comparative damage to those two portions of the strip?

Mr. FERRY. Yes, sir.

Mr. HARDY. Is that the only single test that you made?

Mr. FERRY. That is the only single test that was conducted on an airbase. We have, however, a plethora of tests that were run out at the testing laboratory, by the Corps of Engineers, with their own testing techniques. We have General Wilson here today who could address himself to that point.

Mr. HARDY. Well, on this test strip that you put in, was that—both ends of it—essentially designed to meet the same load?

Mr. FERRY. Yes, Mr. Hardy.

Mr. HARDY. I want to revert for a second to this question of taxiways. You put considerable emphasis on the so-called channelized traffic. Are your taxiways built to the same specifications as your runways?

Mr. FERRY. They would be if they were built today, sir. With the older bases clearly they were not.

Mr. HARDY. How much of your failure on taxiways is due to the fact that they were not built to the same specifications?

Mr. FERRY. I am unable to answer that with facts and figures.

Mr. HARDY. That is the kind of answer you have been giving here all morning.

Mr. FERRY. I do not have that data.

Mr. HARDY. That is the thing that bothers me about your testimony.

Mr. Chairman, that is all. Unless we get some real facts to back up the action which the Air Force has taken, I think they are way

out on a limb. Now if they have facts for it all right. But honest to goodness, when you come in here and get the kind of testimony Mr. Ferry is giving us, frankly I am not impressed by it.

Mr. FERRY. Mr. Chairman, may I address myself to that question?

Mr. HÉBERT. Yes, sir.

Mr. FERRY. I began my statement by saying "I find it desirable to make a few general comments." That is on line 5 of my first paragraph. I intended it only as generalities, Mr. Hardy.

Mr. HARDY. Mr. Ferry, I just asked you a question and you said you didn't have the facts to support it. That has gone on through the whole testimony here this morning.

Mr. HÉBERT. May I suggest this, Mr. Hardy. I join you in your observations, but I also appreciate what Mr. Ferry has said. I suggest that what Mr. Ferry really means when he says he does not have the facts and figures, he means the facts and figures will be available when the other witnesses are on the stand; is that correct?

Mr. HARDY. That is fine, if that is the case.

Mr. FERRY. That is what I intended to convey.

Mr. HÉBERT. I think if you say that, that would indicate to Mr. Hardy what you really mean. You are not an expert.

Mr. FERRY. That is right.

Mr. HÉBERT. But you do intend that all these general statements which have been made in here will be substantiated by your technical people.

Mr. FERRY. We can substantiate them, Mr. Hébert, I believe to the satisfaction of the committee.

Mr. HÉBERT. The committee expects you to substantiate them.

Mr. FISHER. Mr. Ferry, maybe I overlooked it, but where was the Kelly test? Where did it take place?

Mr. FERRY. It was down at Kelly Air Force Base in San Antonio, Tex.

Mr. FISHER. That is the reason you call it the Kelly test?

Mr. FERRY. Yes.

Mr. FISHER. Was that test carried on in consultation or in collaboration with the asphalt people?

Mr. FERRY. They were informed of the test and came down at least once during the progress of the test to observe what was being done.

Mr. FISHER. I recall that I was quite impressed in the prior hearing by the great progress that the asphalt people have been making in improving the type of product that they are able to put out. It would be interesting to see what their comment is about that when they get to bat, and also what additional research and improvement they have made that puts them in a better competitive position with cement.

That is all, Mr. Chairman.

Mr. MILLER. Mr. Ferry, isn't this just a continuation of the old fight that has always taken place between asphalt and rigid type pavements, through the years over the highway program?

Now, I remember prior to World War I, when I was in college, they taught us that bridges along highways were temporary structures, subject to replacement, but once you surfaced a highway it was a permanent structure that was there for all times. With the development of the automobile, we just reversed our thinking. And we

found after some time that concrete was good in one place, and asphalt was good in another, and subsoil and a lot of things were the determining factor.

Now, doesn't that pretty well reflect itself in this instance, too?

Mr. FERRY. I think that is quite true, sir, with one additional factor.

If I might take generalities, again, for a moment: There are certainly places where the subsoil would be such that you would clearly be warranted in using a flexible type of pavement. Also, where weather conditions—as, for example, at Thule, where it would have been almost impossible to lay any quantity of concrete, due to the terrible weather.

Mr. MILLER. You get certain clay globules that absorb three times their weight in water.

Mr. FERRY. Yes.

Mr. MILLER. You find that flexible roads went in and concrete roads were absolutely impossible to put in and maintain.

Mr. FERRY. There is no question but that there are specific places where flexible pavement is indicated in preference to a rigid and a rigid pavement is indicated in preference to a flexible.

But the one salient factor that I keep coming back to again and again and again: the Air Force is different from a highway commission. If you have a highway commission failure of roads, you go out and repair it.

We can't afford to shut down airfields while we are making major repairs. I mean it interferes with our operation. That is the factor that I keep in the front of my mind.

Mr. MILLER. Well, have we gone far enough and do we know it, particularly in this era when we are increasing the weight of planes—surely the introduction of the jet plane caused a lot of problems that weren't foreseen 20 years ago, before the advent of the jet.

Do we know enough or can we build airports or runways today and say that they are going to meet the requirements of anything but in a very short foreseeable future?

Mr. FERRY. This is nothing but a personal opinion, sir.

I believe that airplines have substantially reached a peak in load. I do not anticipate that they will increase substantially in weight from here on in.

I may be a very bad prophet, sir, but that is our feeling at the moment.

Mr. MILLER. 25 years ago, wouldn't you have found people that would have said substantially the same thing?

Mr. FERRY. They might have said it then, but they did not have the background of experience behind them on which to base such a judgment. Today we have a background of experience and we have learned that there is an economic limit at which it no longer pays to make airplanes bigger and heavier. I believe in my own personal judgment that we have about reached the economic weights of airplanes.

Mr. MILLER.. I was going to say for the benefit of my friend from Iowa when he was speaking about that old conflict between asphalt and cement pavements, it wasn't so many years ago we had a third factor in there. We used a big amount of brick. We used to build highways out of brick, but that has gone out of fashion. We were

told at that time that the only thing that could resist heat and cold was brick.

Mr. CUNNINGHAM. Will the gentleman yield?

Mr. MILLER. Yes, I yield.

Mr. CUNNINGHAM. At about that time, during World War I, they built a 14-mile strip of solid brick paving between the city of Des Moines and what was then known as Camp Dodge. Hot weather came, and bricks would fly 50 feet in the air.

Mr. MILLER. We found in California in comparatively recent times, that we go in and put in a concrete highway——

Mr. CUNNINGHAM. I might say to the gentleman that is asphalt, too.

Mr. MILLER. That is right.

Mr. HÉBERT. Let's get back.

Mr. RIVERS. Mr. Chairman, these old folks are reminiscing. Let's get down to modern thought.

Mr. MILLER. Remember, the past is prologue.

Mr. HÉBERT. Let's get back on the track.

I could throw a few oyster shells in from Louisiana, too.

Mr. COURTNEY. Mr. Ferry, I have a few questions on your statement.

On page 1 of your statement, I call attention to it—I suppose you mean immobilization of March Air Force Base by failures. I will ask you two questions. First, was the pavement at March Air Base designed for the modern-type plane to which you have been referring?

Mr. FERRY. Not in total; no, sir.

Mr. COURTNEY. Did the failures occur where the design was not adequate to meet the necessities of the present-type aircraft?

Mr. FERRY. I am going to turn to my technical expert to answer that question. I can't address myself to that.

Mr. COURTNEY. All right.

Mr. GAVIN. Bring the others up here, and let them sit around you, so if you can't answer the questions, they can.

Mr. COURTNEY. First of all, your name and your rank and your responsibilities.

Colonel ALEXANDER. W. D. Alexander, colonel, United States Air Force, Chief, Engineering Branch, Directorate of Construction.

Mr. COURTNEY. And how long have you been in your present assignment?

Colonel ALEXANDER. Four years, sir.

Mr. COURTNEY. Are you familiar with the failure to which Mr. Ferry referred to at March Air Force Base? The question was the pavement which failed there—first of all, what type of pavement was it?

Colonel ALEXANDER. It was flexible pavement.

Mr. COURTNEY. Was the pavement designed for the load which it was carrying at the time of the failure?

Colonel ALEXANDER. Yes, sir.

Mr. FERRY. Not totally. Not all.

Colonel ALEXANDER. 100,000. The B–47 was operating on 100,000-pound pavement.

Mr. COURTNEY. Was the pavement in use at that time, which you say failed, designed for 100,000-pound weight load?

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. And how extensive was the failure?

Colonel ALEXANDER. There were major failures along the center line of one taxiway and in portions of an end of the runway.

Mr. COURTNEY. And to what do you attribute the failure?

Colonel ALEXANDER. The investigations of the failure were made by the Corps of Engineers, and it was attributed to excess moisture in the lower layers of the base, or of the subgrade—not the base.

Mr. COURTNEY. Then that would be a failure in design, would it not, rather than of pavement?

Colonel ALEXANDER. Well, sir, you might call it that. But the pavement—I will go back to to your original question. The March Air Force Base was designed in accordance with the best practice, and the current design for 100,000 pounds.

Mr. COURTNEY. Well, let me ask you this question. If your subgrade won't support your pavement, it doesn't make any difference what kind of pavement it is.

Colonel ALEXANDER. That is correct.

Mr. COURTNEY. Now, your failure in this instance was below the grade of the pavement, isn't that right?

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. I will ask you this question.

Did this failure occur all of a sudden or did you have any warning of it?

Colonel ALEXANDER. No, sir; pavements don't fail suddenly.

Mr. COURTNEY. I didn't think so.

Over how long a period did you experience this deterioration in the subgrade?

Colonel ALEXANDER. I can't answer that directly, Mr. Courtney.

Mr. COURTNEY. Is there some information on that subject?

Colonel ALEXANDER. Yes, sir. We can get you a documented report from the Corps of Engineers which will give you full details on it.

Mr. COURTNEY. And that will be supplied. At some place or other along this hearing?

Mr. FERRY. Yes, sir.

(The report on March AFB, Calif., follows:)

MARCH AFB, CALIF.

Nature of failure: Settlement and rutting of flexible pavement.
Time of failure: Early 1954.
Extent of failure: ----------
Where located (on primary taxiway): Along channelized section of taxiway.
Cost of repair: $74,000.
When constructed: 1953.
What aircraft weightload constructed for: 100,000 pounds on twin wheels.
Had any reconstruction occurred: No.
If so, what was it: ----------
What aircraft were using base: B–47, KC 97.
Would failures have occurred regardless of surface type pavement: Unknown.

Mr. COURTNEY. Now, Mr. Ferry, to come back to your statement, please, on page 3: I notice that you attribute—you have several numerals down there on failures of bituminous pavement since 1950.

Mr. HÉBERT. Mr. Courtney, may I interrupt you just one minute, please? I want to ask the Colonel one question, following through what you have said. And that is—as I understood your statement, it was that the design was at fault?

Colonel ALEXANDER. No, sir; I did not say that.

Mr. HÉBERT. What did you say?

Colonel ALEXANDER. I said——

Mr. GAVIN. He said the substructure was at fault.

Mr. COURTNEY. Subgrade.

Mr. HÉBERT. Subgrade.

Colonel ALEXANDER. No, sir. The pavements at March were designed in accordance with the current criteria and the best knowledge available at that time.

Now, subsequent to this time, the effect of channelized traffic were discovered and provision have been made in subsequent designs for channelized traffic.

Mr. HÉBERT. Indicating that the design was a faulty one.

Mr. FERRY. The best of the state of the art at that time, let us call it.

Mr. HÉBERT. All right.

Then it developed that in reality it was the design and not the fact that it was asphalt.

Mr. FERRY. I can't answer that, sir. I haven't seen the report.

Mr. HÉBERT. That is what we want the Colonel to answer.

Colonel ALEXANDER. Yes, sir. I think you will have to say that, but I believe this report will give you more details on it.

Mr. HÉBERT. No. We want it in language we can understand. In attempting to get this whole matter down on a public record, we don't want the public to have to read these detailed reports.

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. That is why we are asking you in ordinary, plain layman's question, and the reason I return to Mr. Courtney's question. Now, couldn't that same situation have developed with concrete as well as asphalt?

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. So you cannot charge it against being the inferiority of the asphalt?

Colonel ALEXANDER. That is correct.

Mr. HÉBERT. So any advancement as a classic example of the inferiority of asphalt is not quite accurate?

Colonel ALEXANDER. That is correct.

Mr. HARDY. Mr. Chairman, I was just wondering if maybe we haven't another factor that we are not giving enough attention to there. Not only do you have the possibility of design error but you also have the possibility of construction error?

Colonel ALEXANDER. That is correct.

Mr. HARDY. It would have been just as possible for construction error to have taken place, whether it had been rigid or flexible pavement.

Colonel ALEXANDER. That is correct.

Mr. FERRY. I would like to take issue——

Mr. HÉBERT. One second, Mr. Ferry.

Following what Mr. Hardy has said, supplementing that, that is exactly the point I am trying to bring out, Mr. Hardy, is that this was advanced as the failure of asphalt, as a classic example, and in reality asphalt was only an incident in it.

The same thing could have occurred with concrete.

Mr. HARDY. That would be my understanding.

Mr. MILLER. Will the gentleman yield?

Mr. HÉBERT. Mr. Miller.

Mr. GAVIN. I am waiting to be heard on your question, Mr. Chairman.

Mr. HÉBERT. I will yield to you.

Mr. GAVIN. I don't think the colonel was trying to leave the impression that it was a matter of rigid or flexible pavement that was responsible for the condition that arose there. It would have happened whether it was either. He was not trying to convey to us that it was a condition of the materials that were used.

What you said: the base on which the pavement was built, whether it was flexible or rigid, had no bearing on it, that there was some ground condition existed there, some subbase that existed that was responsible for the condition that arose there; is that right?

Colonel ALEXANDER. That is right.

Mr. GAVIN. You didn't at any time try to infer that it was because of any particular materials or the type, rigid or flexible.

I concluded from what he said—and I am only trying to defend his position—the fact that it was the base on which the airstrip was laid, and not the materials that were used.

Mr. HESS. Will the gentleman yield? I don't believe anybody on the committee has said that the colonel made such a statement. What we are referring to is this list of Air Force bases at which major repairs and replacement of asphaltic concrete has been accomplished.

Mr. GAVIN. I quite agree, but the chairman is trying to bring out the point that it would have happened in any event. I quite agree with it, that is right, but the colonel didn't say that.

Mr. HÉBERT. The chairman is not trying to say nor at any time did he indicate in his questions that the colonel was attempting to avoid answering the question. The chairman was merely trying to bring out by questioning exactly what the situation happened to be at the time, and what the facts were. Certainly, he had no intention and I am sure the colonel knows it—and with the exception of the gentleman from Pennsylvania, nobody got any other idea.

Mr. HÉBERT. Mr. Miller.

Mr. MILLER. Mr. Chairman, I would like to clarify this in my own thinking. You said at the time this base was constructed, the then best criteria—it was constructed with the best critera at the time, that is correct, is it?

Colonel ALEXANDER. Yes, sir.

Mr. MILLER. In other words, at that time this was the best engineering thinking?

Colonel ALEXANDER. Yes.

Mr. MILLER. You built this base on a subbase, and built this runway on it, and it subsequent failed.

It goes back to what I said to Mr. Ferry. When I questioned him, it was brought out that the subbase has a great deal to do with these things, and that this is the same old fight.

We are making progress.

Are we sure, or would you as an engineer say that you can design a base today using the best criteria that will meet perhaps the advancement of 10 years from now?

Colonel ALEXANDER. For flexible pavement?

Mr. MILLER. For any kind of a pavement. I don't care what it is.

Colonel ALEXANDER. Yes, sir.

Mr. MILLER. You think you could do it now and it would be a good 10 years from now?

Colonel ALEXANDER. Well, if we go back to Mr. Ferry's statement——

Mr. MILLER. I am talking about you, now. You are going to approve of the building of a base today, and you are going to sit there, and dogmatically tell me you can do it and it is going to be good 10 years from now? When was March Field built?

When was this pavement laid?

Colonel ALEXANDER. 1950—subsequent to 1950.

Mr. MILLER. Do you think the man who laid this—the engineer who would have been in your position if I asked him then, wouldn't he just have answered me as you did, and said, "Yes, I can do it"?

Colonel ALEXANDER. Yes.

Mr. MILLER. You think you can do it?

You think you have more brains or the engineers know more today than your forebears did just 7 years ago?

Colonel ALEXANDER. We think we do.

Mr. MILLER. You think you do. Don't you think they thought people in 1943 were pretty antiquated in their thinking?

Colonel ALEXANDER. Yes, sir, things have progressed.

Mr. MILLER. You don't think we are at the end of that progress, do you?

Colonel ALEXANDER. No, sir.

Mr. MILLER. You wouldn't try to tell me, dogmatically tell me, pontifically sit there and tell me, "I can build a runway today that will be good 10 years from now"?

Colonel ALEXANDER. I wouldn't tell you dogmatically. I would say I think we can do it.

Mr. MILLER. "Think"?

You think you can do it. That is what I wanted you to say. We are at the place where you can't know and don't know. And there is no throwing aspersions on what has taken place in the past. The people that built these bases built them to the best criteria, using your statement.

Mr. HÈBERT. We are right back where we were with Mr. Courtney, when I interrupted.

Mr. RIVERS. Let me ask a question.

Mr. HÉBERT. Ask your question.

Mr. RIVERS. I wanted to ask this. When Mr. Courtney brought it up I started to object. He asked a question of Colonel Alexander, as to whether there was a weakness in the design of March Field. From what has transpired, it looks to me like the weakness was a faulty inspection of faulty contracting, because you didn't get enough water out from the bottom.

There was water underneath the runway. I want to ask this question: was it faulty inspection, faulty design, or faulty construction?

Colonel ALEXANDER. I believe, Mr. Rivers, the fault of that failure would have to be borne out in the design.

Mr. RIVERS. In the design.

Colonel ALEXANDER. And since that time of course, we have improved our knowledge in design.

Mr. RIVERS. How can design get away from the water that is underlying a runway, if you don't remove the water table?

Colonel ALEXANDER. If a man properly designed a facility or structure, he will ascertain whether the water will get in there or not or he will attempt to ascertain that.

Mr. HÉBERT. Mr. Courtney.

Mr. GAVIN. Would you yield at that point?

In the design of a base of that magnitude, and importance, wouldn't you make test borings of the land under that runway before you went in and designed it?

Colonel ALEXANDER. Yes, sir.

Mr. GAVIN. To find out what the substructure was?

Colonel ALEXANDER. Yes, sir.

Mr. GAVIN. Was that done in this case?

Colonel ALEXANDER. Yes, sir.

Mr. GAVIN. And still you had water under there?

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. Mr. Courtney.

Mr. CUNNINGHAM. Mr. Chairman, could I clear up something with Mr. Ferry?

Mr. HÉBERT. Yes.

Mr. CUNNINGHAM. You said earlier, Mr. Ferry, that the safety division might have the figures of comparison between the flexible and nonflexible. Could you get those figures for us?

Mr. FERRY. I will try to, sir.

Mr. HÉBERT. Mr. Courtney.

Mr. COURTNEY. Mr. Ferry, at top of page 3, in the course of your statement, you made reference to what is described as an alarming number of major failures in pavements.

We have distinguished here, and do distinguish, between the critical areas as they were described in the 1954 hearings, and the rest of the pavement at the airfield.

I will ask you whether or not the alarming number of major failures to which you referred did not in fact occur in what would be described as critical areas?

Mr. FERRY. Yes, sir.

Mr. COURTNEY. So as between the Air Force and the subcommittee, there is no difference of opinion now as to whether or not those areas ought to be in concrete or rigid pavement?

Mr. FERRY. We are now talking of the 1954 critical areas?

Mr. COURTNEY. Yes, sir.

Mr. FERRY. No difference at all.

Mr. COURTNEY. Then failures of that character so far as present criteria are concerned would not occur in the future?

Mr. FERRY. I will not go so far as to say that, sir.

Mr. COURTNEY. That is so far as the type of pavement selected?

Mr. FERRY. Again, I would not go so far as to say that.

Mr. COURTNEY. I notice also in describing these failures that you break down the failures into the bituminous runway ends which have been replaced. Of course, in the 1954 criteria it was established that 1,000 feet at the end of all runways would be rigid pavement.

Mr. FERRY. Yes, sir.

Mr. COURTNEY. That, of course, would not be a failure to be considered for the future?

Mr. FERRY. That is right, sir.

Mr. COURTNEY. I am merely trying to isolate the problem, if we can, by eliminating things as to which an agreement has been reached.

Mr. FERRY. May I touch for just a second on that, Mr. Courtney?

Mr. COURTNEY. Yes, sir.

Mr. FERRY. We are really talking now of new airfields, because our airfields today are substantially constructed and with the exception of some lengthening at the end which clearly should be concrete, some additional paving areas for the larger-sized planes to take them, we are practically finished building new airfield pavement. So the thing is in a form—not academic. Certainly, we will always be doing some paving, but it is not of the same importance as I think it was back in 1954.

Mr. COURTNEY. I notice that in your prepared statement, you make frequent reference to the frequency of use of these pavements.

Mr. FERRY. That is right.

Mr. COURTNEY. And again, in the course of your statement and your interpolation, you referred to the change in the use of these airfields by reason of dispersal.

Mr. FERRY. Yes, sir.

Mr. COURTNEY. I think you also said that a field infrequently used would not be designed for as heavy a load as the 240,000-pound load.

Mr. FERRY. That is correct, sir.

Mr. COURTNEY. Then frequency of use is one of the very vital factors, is it not, in determining the type of design which you shall employ and the type of pavement which you may require on primary taxiways?

Mr. FERRY. It is one of the most important.

Mr. COURTNEY. The most important.

Mr. FERRY. One of the most important factors.

Mr. COURTNEY. Have you made any comparison, Mr. Ferry, in the establishment of the present criteria between the experiences of the Air Force versus the experiences of our commercial airfields, where, for example—take Midway Airfield in Chicago, which is one of the heavily traveled and used airfields; have you made any comparison between the design which is proposed for the Air Force, and the design which is employed or to be employed at Midway, for example, or the other commercial airports where they have—the frequency factor?

Mr. FERRY. We have not, sir, because the primary requirement of a commercial airport does not have the imposed loads that we will impose on them, with our heavy bombers. So we have one of the factors that just has no analogy.

Mr. COURTNEY. In other words, the only comparison then would be on the element of frequency?

Mr. FERRY. We could compare on the element of frequency, but that would leave out the question of weight, imposed load.

Mr. COURTNEY. Not on the question of imposed load.

Mr. FERRY. That is right.

Mr. COURTNEY. That is all, Mr. Chairman.

Mr. FERRY. May I elaborate?

Mr. COURTNEY. Yes, sir.

Mr. FERRY. Colonel Alexander mentions our tire pressures are higher than commercial tire pressures as well, which, of course, ties into the question of the weight of the plane.

Gentlemen, I would like to say that I have tried to be completely objective. In using March Field, as an example of interruption, no attempt was made to tie it to flexible pavement or rigid pavement. I merely said it is an example of the interference that we can't tolerate in the Air Force by the reason of major repairs.

It was not an attempt to cast aspersions.

Mr. HÉBERT. Mr. Ferry, has a similar occurrence taken place at a place where there was rigid pavement?

Mr. FERRY. No, sir. We have had repairs on rigid pavement, but no shutdown of a field.

Mr. HÉBERT. No shutdown such as at March Field.

Mr. FERRY. And secondly, I would like to add one question.

I am sure you will not take this as personal, Mr. Hardy. I am a professional engineer, and as such would not care to appear and comment about things that I could not back up as an engineer.

We have available engineering data I think which will be able to show to the committee and I trust convince them of the soundness of my presentation.

Mr. HARDY. Mr. Chairman, if I might just make this observation? Of course, I should certainly be glad to get that kind of information, Mr. Ferry. I don't know that I am too concerned with getting the technical information. But I do want to have some engineering evaluation of facts.

Frankly, I was a little bit disturbed by your expression that you didn't have the facts. So if somebody else is going to supply them, that is fine.

Mr. FERRY. All right, sir.

Mr. HÉBERT. Thank you very much, Mr. Ferry.

Mr. FERRY. Thank you.

Mr. HESS. Mr. Hébert.

Mr. HÉBERT. Yes.

Mr. HESS. I would like to ask Colonel Alexander a question or two here with reference to this seal-coat and tar-rubber overlay.

Have those been successful when they are applied over the bituminous concrete—not taxiways, but hardstands and places of that kind, where there might be spillage?

Colonel ALEXANDER. Not fully, Mr. Hess.

We placed tar-rubber on quite a few bases, more as an experimental and a reserve project, subsequent to our last hearings. We have had indications that the tar characteristics permeate the pavement. So we get a certain amount of cracking and checking. However, that is not prevalent on all of them. We still have hopes that the tar rubber pavement holds promise and it may be of some help to us.

Mr. HESS. Would it be as costly as concrete?

Colonel ALEXANDER. No, sir.

Mr. HESS. All right. That is all.

Mr. RIVERS. Could I ask the colonel a question? Colonel, what is your job?

Colonel ALEXANDER. Chief of the Engineering Branch of the Directorate of Construction, in Headquarters, Air Force.

Mr. RIVERS. Under whom do you work?

Colonel ALEXANDER. I work under Colonel Lutz and Colonel Conner.

Mr. RIVERS. Who is in charge of it?

Colonel ALEXANDER. Colonel Conner is the director of construction.

Mr. RIVERS. Who is the general in charge of it?

Does that come under Installations?

Colonel ALEXANDER. Yes, sir. General Minton is the Assistant Chief of Staff, Installations, and I work under him, through these other officers.

Mr. RIVERS. He took General Washbourne's place?

Colonel ALEXANDER. Yes, sir.

Mr. FERRY. May I at this point present General Minton to the committee? Gen. Augustus Minton, the new head of the Installations Division. [General Minton rose.]

Mr. HÉBERT. This is your first appearance here?

General MINTON. This is my first appearance. I have just been here 1 week.

Mr. RIVERS. He is a one-star general, and General Washbourne is two-star.

Mr. FERRY. That is right.

Mr. RIVERS. Is that permanent, to have a one-star general to take the place of a two-star general?

Mr. FERRY. We sincerely believe that we will be able to improve the mission of General Minton.

Mr. HÉBERT. We have no further questions.

Mr. FERRY. I would like to then put on Colonel Conner, who is the Chief of Engineering in Installations Branch of the United States Air Force.

Mr. RIVERS. Before Mr. Ferry goes, I hope you won't change that statement for the record. Not knowing his abilities, I hope you won't change it, that you are going to work to improve his star condition.

Mr. FERRY. I was addressing myself, Mr. Rivers, to the number of stars.

Mr. GAVIN. Where is Colonel Conner located?

Mr. FERRY. Colonel Conner is located over in the Pentagon, on the fifth floor of the Pentagon.

Mr. GAVIN. Isn't there another Colonel Conner in Spain on the development of air bases?

Mr. FERRY. You are thinking of Kelly.

Mr. GAVIN. No, I am thinking of Conner.

Mr. FERRY. There is no Conner in Spain.

Mr. GAVIN. There isn't much difference between the two of them. They are both good Irish names.

Mr. FERRY. Colonel Conner, will you take the stand?

Colonel Conner will be very glad indeed to answer any engineering questions and put in evidence the engineering studies that we have made on the pavements.

Mr. HÉBERT. Colonel, will you identify yourself for the record?

Colonel CONNER. Robert R. Conner, Colonel, U. S. Air Force, Director of Construction, Assistant Chief of Staff, Installations, United States Air Force. I have no prepared statement.

Mr. HÉBERT. You have no prepared statement, sir?

Colonel CONNER. No, sir.

Mr. HÉBERT. Mr. Hardy?

Mr. HARDY. Mr. Chairman, I don't have notes here on the specifications that I had in mind discussing with Mr. Ferry. But Colonel, I was somewhat concerned that Mr. Ferry's statements were so general. He didn't indicate that they were based on any comparative engineering studies.

As one specific illustration, on page 3 of Mr. Ferry's statement he referred to the fact that of the bituminous pavements constructed in 1950, 47 have had major repairs or replacements.

Now, do I understand from that that no rigid construction in that same period has required any major repair?

Colonel CONNER. We have had no major repair trouble with rigid pavement since that time, no, sir.

Mr. HARDY. What constitutes major repairs as contrasted to minor repairs?

Colonel CONNER. Just as an opinion, I would consider major repairs to be in those areas of around $50,000 or more that would depart from the area of maintenance as such and become rehabilitation projects.

Mr. HARDY. So your point of departure, then, is $50,000 in cost.

Colonel CONNER. Yes.

Mr. HARDY. Rather than on an area basis, it is a cost proposition.

Colonel CONNER. Yes.

Mr. HARDY. Do you have any figures to indicate comparative costs of maintenance as between your asphalt and your portland, of runways constructed during the same period of time?

Colonel CONNER. We have no firm figures on maintenance. The maintenance accounts on air fields in the Air Force are kept by airfields alone and are not broken out into the repair of individual areas of pavements.

Mr. HARDY. Mr. Ferry's statement referred to pavements, and he didn't distinguish between runways, taxiways, warmup pads or what not. Is there any appreciable distinction in the experience with respect to those different types of pavements, usewise?

Colonel CONNER. Usewise, it is my opinion that it would be pretty well across the board, wherever pavement is used.

Mr. HARDY. Is there any engineering data to demonstrate that, or are we just talking about opinions now?

Colonel CONNER. I will have to ask Colonel Alexander if there are any of those figures available.

Colonel ALEXANDER. I think we could cite approximately 8 or 10 jobs and give you a short description of those jobs or bases——

Mr. HARDY. Colonel, I don't mean to get into that.

Colonel CONNER. Yes, sir.

Mr. HARDY. The only thing—I don't want to evaluate this business, but I want to know that some engineer has made an actual engineering comparison and engineering study and doesn't come in here and base his statements on opinions and judgments, unless they have something of an engineering nature to back them up. Most of Mr. Ferry's statements were statements of opinion. He said he didn't have the facts. I haven't got the questions before me, but there were a number of times that he gave answers that simply said he didn't

have the facts to support his position. I am assuming that you people do. If I had those questions here, I would like to put them to you individually, but I don't have them. I just don't like to get an engineering expression based on opinion.

Colonel ALEXANDER. Mr. Hardy, we can show our major pavement failures and show you the cost of those failures. I believe that is right there in that letter.

Colonel CONNER. That is right. We have some prime examples here, Mr. Hardy. We can get others from our files.

At March Air Force Base, the cost of rehabilitation of that job was in the neighborhood of $72,000. That pavement was put in use in May of 1952. It subsequently developed these long-rolling undulations on the pavement and the repairs and major rehabilitation of that job required taking off the high spots and filling in the low spots. It cost us $72,000.

Mr. HARDY. Now, let's talk about that one a little bit more. Colonel Alexander's testimony was that the engineers, Army engineers, had made an evaluation of that whole picture and had concluded that the problem there was one of subgrade construction. Now, is there any engineering evaluation of that which would make a comparison with what would have happened if it had been portland concrete rather than asphalt?

Colonel CONNER. No, sir, not unless the Corps of Engineers made one. And that was their job, sir. I would rather they would explain their report to you.

Mr. HARDY. Well, my whole point is simply this, Colonel. I think you understand it. Apparently you would have had trouble with that runway regardless of whether—regardless of what the surface was, because of the subgrade.

Colonel CONNER. It is our experience, sir, that flexible pavement with an asphaltic concrete top is more generally prone to subsidence caused by deferential settlement than rigid concrete slabs are.

Mr. HARDY. Now, have you any engineering, comparative engineering data to back that up, or are you just again talking about experience based on opinion that might have a little prejudice involved, too, I don't know?

Colonel ALEXANDER. I think these facts that Colonel Conner is talking about—they are facts, Mr. Hardy. They are not, really not——

Mr. HARDY. You have facts?

Colonel ALEXANDER. Yes.

Mr. HARDY. You have some undulations, I believe was the word.

Colonel ALEXANDER. Yes.

Mr. HARDY. On asphalt pavement.

Colonel CONNER. Yes. What are the facts as to what would have happened over the same subgrade if you had had portland concrete?

Colonel ALEXANDER. The only way that could be answered is if we had built the concrete there and subjected it to the same traffic. But I don't believe——

Mr. HARDY. Can you say with precise engineering assurance that if that particular runway had been constructed of rigid concrete to start with you wouldn't have had any trouble with it?

Colonel CONNER. We can't say that, sir.

Colonel ALEXANDER. No.

Mr. HARDY. That is just what is bothering me, Colonel.

Now, I just—I would like to get some engineering evaluation.

Now, back in 1954, which is 3 years ago almost—not quite 3 years ago—in a letter to Mr. Hess, who was then chairman of this subcommittee, Mr. Ferry had this to say, and I am quoting from his letter:

While we are completely convinced—

and that is a very strong statement—

we are completely convinced that 100 percent concrete paving has a definite advantage as compared to a combination of concrete in the critical areas and asphalt in the noncritical areas, we have been unable to collect adequate engineering backup as reflected by maintenance cost to substantiate this view.

Now that was 3 years ago. I don't know what—certainly you have had 3 years in which to collect adequate engineering cost data. I just asked for some cost data on maintenance, and Colonel Conner said he didn't have it. So apparently you haven't brought it together in Washington. Maybe you have something else, Mr. Ferry. I am glad you came back.

Mr. FERRY. May I address myself to that, Mr. Hardy?

Shortly after that hearing in 1954, I realized the inadequacy of our figures. They didn't have them. We don't have them today. This may sound not very good management, but I have been trying for 3 years to get a worldwide system of evaluating the cost of maintaining and repairing airfield pavements, not only by pavements themselves but by the locations, that is taxiways as separated from runways and from parking aprons and such. And due to the very inertia and complexity of getting that into the accounting system, I haven't got it going yet.

Mr. HARDY. Well, you just put your finger on the whole thing that bothers me about this proposition. The Air Force has made decisions to use concrete. Maybe they are right. I certainly don't know. But I would still have to come back to this observation, that if you have developed any engineering support for that, you haven't given it to this committee.

Mr. FERRY. Sir, the only thing we can give you is frequency. We can't give you dollar maintenance cost. But we have figures on the number of failures of concrete as against asphalt, and the overwhelming number of failures lies in the flexible type paving.

Mr. HARDY. Well, now, it looks like that when you get into this question of failures, what constitutes a failure, you have it set up on a cost basis. Colonel Conner says that if it costs over $50,000 it is a failure. If it costs under that, it just goes into your maintenance cost and you don't have any tabulation of it. I don't know. It doesn't mean too much to me because you haven't given us any figures that I have been able to find—I am not interested in figures. But I want to be sure that somebody has the figures and that qualified engineers have passed on them. And you haven't given us anything to indicate that at all.

Mr. FERRY. Mr. Rivers, all we can furnish you at this time is frequency of failures.

One sometimes must reach conclusions from an engineering standpoint without having all of the engineering data available. Frequently you have to make decisions to go forward, while you are waiting to get all that you would like to have. And this is one

of our cases. We have to make a decision how to go forward to the future.

Mr. MILLER. Will the gentleman yield?

Mr. HARDY. I'm through. I'm not getting anywhere.

Colonel CONNER. Mr. Hardy, from a maintenance standpoint there has hardly been any good continuity of maintenance figures. We most generally had to go to major rehabilitation jobs and strengthening jobs before any day to day maintenance in some of these places was required.

Mr. HARDY. Well, one of the bases that you have in there, and it is a big one, is Nouasseur. I was out there when that one was being constructed. I would have a little trouble understanding how you contribute that to either surface, the trouble that you had out there.

Mr. HÉBERT. Mr. Bates, any questions?

Mr. BATES. Mr. Ferry, have you coordinated your study with that of the Navy?

Mr. FERRY. No, sir.

Mr. BATES. Has the Department——

Mr. FERRY. I am reporting Air Force experience only.

Mr. BATES. Has the Department of Defense put out any instructions on that at all?

Mr. FERRY. Department of Defense has given us permission to construct pavings to withstand the necessary imposed loads, and they do not say specifically it shall be rigid or flexible, but they do give us permission to provide sufficient strength in our pavements to meet the requirement.

Mr. BATES. Then they pretty well leave it up to you?

Mr. FERRY. That is right, sir.

Mr. BATES. Now if you haven't coordinated your experience with that of the Navy, do you know what Navy does?

Mr. FERRY. I do not, sir, for the reason that they do not have the same problem we have, of this question of weight, Mr. Bates.

Mr. BATES. No, but at many bases—they have many of your type bases which are used for planes identical to their's. Many of your fighters and their fighters can be interchanged.

Mr. FERRY. Our trouble is in the heavyweight planes, Mr. Bates. Our major trouble is the heavyweight. It is not the fighter planes that trouble us so much.

Mr. BATES. How about your Air Defense Command, what are you doing there?

Mr. FERRY. In Air Defense Command we are still to a large extent using asphaltic concrete pavings.

Mr. BATES. It is just for your larger bombers that you are using rigid?

Mr. FERRY. That is right.

Mr. HÉBERT. Mr. Ferry, I understood you to say that you have not coordinated with the Navy because the Navy has different problems than the Air Force.

Mr. FERRY. That is right, sir.

Mr. HÉBERT. Who is constructing the Air Force bases in Spain?

Mr. FERRY. The Navy is constructing them for us, sir.

Mr. HÉBERT. They certainly must have something in common with you.

Mr. FERRY. Well, they have something in common with us, but our bases are being constructed for a heavier load than the one down at Rota.

Mr. HÉBERT. The one where?

Mr. FERRY. The Navy base down at Cadiz.

Mr. HÉBERT. Isn't the Navy in charge of all construction in Spain?

Mr. FERRY. That is right, sir.

Mr. HÉBERT. Then they must be cognizant of your problems, aren't they?

Mr. FERRY. They are cognizant of the problem. But the question asked had I correlated this with the Navy, this report, and I said not.

Mr. HÉBERT. You said they had different problems.

Mr. FERRY. That is right, different operating problems.

Mr. HÉBERT. Well, these are construction problems. Don't you think you should correlate your information with the Navy? They are building your bases.

Mr. FERRY. The Navy is our design agency—not only building, but they are designing for us. So they are perfectly aware of our problems because they are providing the design to meet our requirements.

Mr. HÉBERT. Well, still, shouldn't you correlate your information with them? And on an overall basis they certainly have a great interest in you and you have a great interest in them. Or are we still that far from unification?

Mr. FERRY. We are still very close to unification, sir, in this matter of construction, but I had to answer Mr. Bates' question that I had not correlated my views here with the Navy in preparing this.

Mr. HÉBERT. You personally hadn't correlated your views?

Mr. FERRY. I had not.

Mr. HÉBERT. Had the Department correlated their views?

Mr. FERRY. I don't think we have.

Mr. HÉBERT. You are in charge?

Colonel CONNER. They are.

Mr. FERRY. Oh, they are?

Colonel CONNER. Yes.

Mr. HÉBERT. All right.

Mr. BATES. One further question.

Mr. Ferry, you are going to have some 11 new SAC bases on your dispersal program?

Mr. FERRY. There are 6 new ones in this year sir—11 and 6 more.

Mr. BATES. You are going to have the 22.

Mr. FERRY. Right.

Mr. BATES. What do you intend to do at those particular bases?

Mr. FERRY. We are going to have—where the pavements are of insufficient strength to take the weights, we are going to have to put overlays on to take the weight.

Mr. BATES. So at least this inquiry is timely, because we got that very real situation facing us. This determination should be made before you moved them in as tenants.

Mr. FERRY. Yes, sir.

Mr. BATES. On many of these air defense bases.

Mr. FERRY. Yes, sir.

Mr. HÉBERT. Mr. Miller?

Mr. MILLER. Colonel Conner, you say you have a number of these cases. You haven't any engineering data. You merely pick up the

number of failures. The only failure that we have discussed at any length here was March. You are not going to say that March Air Forse Base was a failure because of the type of surface, are you? You just went through pretty well proving that it was a failure of subsurface. I want to know how you are going to tag that one off. Is it going to be attributed to concrete or to asphalt?

Are you going to throw that one out?

Colonel CONNER. No, sir. We have some other examples, Mr. Miller.

Mr. MILLER. I am talking about this one. Now in evaluating these, in these lists of bases here—are we going to put March Air Force Base——

Are we going to credit it to asphalt or—what is it? Is it concrete or asphalt?

Colonel CONNER. Asphalt.

Mr. MILLER. Asphalt. All right. Are we going to give asphalt a demerit on March?

Mr. FERRY. We sure are.

Mr. MILLER. You are going to say that is a failure of asphalt at March?

Mr. FERRY. Yes.

Colonel CONNER. No, sir, I am gong to say it is a failure of flexible pavements.

Mr. MILLER. Let's not quibble. I will use flexible pavements, as against permanent pavement, if you are going to quibble on that.

Are you going to say this is a discredit for flexible pavement?

Colonel CONNER. One of them, yes, sir.

Mr. MILLER. But didn't we just get through saying—didn't this other gentleman just admit there was subsurface and subgrade failure there?

Colonel CONNER. Yes sir; and in the 4 or 5 layers——

Mr. MILLER. He was asked some place up and down the line whether or not under the same conditions permanent pavement would have resisted this as against flexible, and if I remember—I don't want to misquote you, Colonel. As I remember, I think you said you couldn't say that it wouldn't fail under the same conditions, isn't that correct?

Colonel ALEXANDER. I couldn't say unless you have the performance——

Mr. MILLER. You couldn't say it. Are you going to say this is a demerit or are we going to throw March Field out as being a subsurface pavement, that you can't definitely say is due to your flexible or your permanent pavement?

Colonel CONNER. I am going to have to say that as far as I am concerned, it is an example of the failure to produce suitable pavement, suitable flexible pavements.

Mr. MILLER. Then irrespective of the fact that the subgrade admittedly here was responsible for the failure, we are going to then say that this is a failure here. Had that been concrete, it would have gone out—or permanent. Excuse me for using the word concrete.

If it was permanent, would you have said——

Mr. HARDY. Rigid.

Mr. MILLER. Rigid. Excuse me.

I get these things mixed up.

Why don't we just call them asphalt or concrete, and get away with that. Get rid of the gobbledygook. You talked around a lot of

things. You haven't told me yet whether you consider—that you are going to throw out all consideration of the subgrade.

Colonel CONNER. No, I am not going to throw out all consideration of the subgrade.

Mr. MILLER. Then what are we going to say? Are you going to say that this is responsible, that the asphalt pavement or flexible pavement—this is responsible for this failure, and charge it against it, when other data apparently shows that there was a basic fault away from that type?

Colonel CONNER. It has been my experience, sir, that rigid pavements survive better on poor subgrades than flexible pavements do.

Mr. MILLER. On poorer subgrades. Then we get back to the thing—are you satisfied with the subgrades on all of these bases where you have had failures, or were they—are you in the position of your younger friend here, who says, "We have reached the maximum now," in 7 years, "and we do know everything. We have gone all the limit, and nothing is going to happen from now on out, because we have all the answers, and everything that has gone before us has been a little bit foolish."

Colonel CONNER. I think we progress along. We are smarter than the people were 7 years ago.

Mr. MILLER. Do you think the people 7 years from now will be smarter than you are now?

Colonel CONNER. Yes, sir.

Mr. MILLER. I am glad to hear that. I accept that. I am glad to hear somebody from the Air Force say that.

Colonel CONNER. We will be in poor shape if we are not.

Mr. MILLER. I will tell the world we will be in poor shape; any time we quit progressing and any time we admit that we know it all, we are in pretty poor shape.

Mr. HÉBERT. Mr. Courtney.

Mr. COURTNEY. Mr. Chairman, it may be out of the sequence that we normally plan, but, Mr. Ferry, in answer to Mr. Bates' question, you stated that in the new dispersal program it would be necessary to overlay some of the present bases.

Mr. FERRY. Yes, sir.

Mr. COURTNEY. With what substance or pavement would you overlay?

Mr. FERRY. That would be a question of design recommendation from our Corps of Engineers on that matter, Mr. Courtney, depending on the conditions at each of these bases. You see, a pavement consists not only of the pavement itself, but it consists of the subgrade, the subbase, the surface, the bearing values of the soil itself, and each one of these must be an individual engineering study by technicians who are competent to make this sort of an evaluation of how to make an overlay.

Mr. COURTNEY. Well, let me ask you this question. Assuming your rigid-type pavement on any of these bases is inadequate to support the load, what do you do to overlay it or soup it up?

Mr. FERRY. We have had just completed the overlaying of a concrete runway with a concrete overlay, and we are watching it with the greatest of care to see if it is standing up.

Mr. COURTNEY. That is the first such experience?

Mr. FERRY. That is right.

Mr. COURTNEY. And where did that occur?

Mr. FERRY. Where was that?

Colonel ALEXANDER. I can't give you a specific case. We are doing one at Altus right now. That is a thin overlay at Selfridge.

Mr. COURTNEY. A thin overlay at Selfridge?

Colonel ALEXANDER. Yes.

Mr. COURTNEY. Has that method been tested in the laboratories?

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. And you are now putting it into operation?

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. Is that the first such experience?

Colonel ALEXANDER. No, sir. The Pennsylvania Highway Commission put in a short section of this on the Pennsylvania Turnpike.

Mr. COURTNEY. Well, you certainly don't compare a turnpike operation with the kind of operation——

Colonel ALEXANDER. Not at all.

Mr. COURTNEY. You discuss it here, do you?

Colonel ALEXANDER. No, sir.

Mr. COURTNEY. Let's stick then to the Air Force's requirements.

Colonel ALEXANDER. The problem, Mr. Courtney, is when the existing concrete pavement is adequate in strength, but the top of it is spalled, and rough and eroded, then we don't need strengthening of that pavement. We only need a smooth, hard surface.

Mr. COURTNEY. Well, I understand that. You do have spalling and you do have failures of—surface failures.

Colonel ALEXANDER. That is right.

This is strictly a surface failure. That is what Mr. Ferry was referring to.

Mr. COURTNEY. I was talking about souping up pavements for strength.

Colonel ALEXANDER. When you go to souping them up for strength, then you come on with several inches—10, 12, or 14 inches.

Mr. COURTNEY. Of what?

Colonel ALEXANDER. Of portland cement concrete.

Mr. COURTNEY. And what else?

Colonel ALEXANDER. Flexible pavement—either one.

Mr. COURTNEY. Either one.

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. So at that point, your choice is an alternate choice.

Colonel ALEXANDER. No, sir, I don't want to mislead you.

Mr. COURTNEY. All right.

Colonel ALEXANDER. The Air Force criteria today specify portland cement concrete in all the areas that he defined right there.

Mr. COURTNEY. To shorten it up, what we are talking about now is the runway.

Colonel ALEXANDER. Yes, sir. The runway would be overlaid with portland cement concrete.

Mr. COURTNEY. Confine our questions solely to the question of runway.

Colonel ALEXANDER. That is right.

Mr. COURTNEY. That seems to be the only issue or the difference of opinion.

Colonel ALEXANDER. Right.

Mr. FERRY. Taxiways also.

Mr. FERRY. Taxiways, and the runways would be overlaid with portland cement concrete if it is one of our major bases.

Mr. COURTNEY. That is the change since 1954?

Mr. FERRY. Yes, sir.

Mr. COURTNEY. Now, what other experiences have you had, Colonel, on failures of runways?

Colonel CONNER. We have the experience at Pinecastle Air Force Base.

Mr. COURTNEY. And what was the nature of it?

Colonel CONNER. The nature of those was the subsidence all down through the centerline of the runway, caused by the heavy punching of hard tires and sheer weight of the aircraft in rolling.

Mr. COURTNEY. And when did this failure occur, and how extensive was it?

Colonel CONNER. This failure occurred approximately 1 year ago. We had transfer settlement from a zero to a 1-inch deep at midpoint, in some places 100 feet long, and in some places slightly deeper than that.

Aircraft commanders were reporting that the unevenness of the surface causes the aircraft to skip and bounce, affecting breaking action, and porpoising.

Mr. COURTNEY. What type of pavement are you dealing with on this runway?

Colonel CONNER. This runway is asphaltic pavement in the center portion of the main runway.

Mr. COURTNEY. And what weight or what load were you putting on the runway when the failures occurred?

Colonel CONNER. That load was somewhat less than 100,000 pounds.

Mr. COURTNEY. And for what load was the pavement designed?

Colonel CONNER. 100,000 pounds.

Mr. COURTNEY. And where did the failure occur, on the surface or in the subgrade?

Colonel CONNER. Both places, sir.

Mr. COURTNEY. Both places.

Colonel CONNER. In all layers. From the base course through to the wearing course—the base course, the subgrade and the wearing course.

Mr. COURTNEY. So that the whole design failed, did it not? The subgrade gave way and the pavement gave way?

Colonel CONNER. It had some subsidence.

Mr. COURTNEY. Which came first?

Colonel CONNER. That would be hard to say, sir. That is the reason I mentioned flexible pavement, because it is built up of these many layers, and a failure in any one of the layers can cause a failure of the entire structure.

(The report on Pinecastle AFB, Fla., follows:)

PINECASTLE AFB, FLA.

Nature of failure: Settlement of flexible pavement.
Time of failure: During 1956.
Extent of failure: Approximately 7 feet wide and 10,000 feet long.
Where located on runway: Along centerline.

Cost of repair: $197,166.
When constructed: 1953.
What aircraft weightload constructed for? 100,000 pounds on twin wheels.
Had any reconstruction occurred? No.
What aircraft were using base? B–47 and KC–47.
Would failure have occurred regardless of surface-type pavement? No.

Mr. COURTNEY. What other failures have you?

Colonel CONNER. Another failure at Castle Air Force Base, similar to the one——

Mr. COURTNEY. This again is runway?

Colonel CONNER. This again is runway.

Mr. COURTNEY. Let's stick to runways, or taxiways.

Colonel CONNER. This is similar to the one at Pinecastle, although the depressions are somewhat deeper. They go up to three-tenths of a foot in some places.

Mr. COURTNEY. Again, for what weightload was this pavement designed?

Colonel CONNER. Castle was designed for 100,000-pound pavement.

Mr. COURTNEY. And what weight did you have on it?

Colonel CONNER. We had heavier weights than that on it, slightly heavier. We were using B–52's, although they weren't fully combat loaded.

Mr. COURTNEY. But you exceeded the weightload of the pavement?

Colonel CONNER. We exceeded the weightload.

Mr. COURTNEY. And the pavement failed; is that right?

Colonel CONNER. Yes, sir.

Mr. COURTNEY. Now, Colonel, to what do you attribute the failure?

Colonel CONNER. The failure on that one could have been any number of poor conditions in either—I won't call it design, but probably construction deficiency.

Mr. COURTNEY. Construction deficiencies.

Colonel CONNER. Construction deficiencies.

Mr. COURTNEY. Just explain that a little bit so we don't get lost here.

Colonel CONNER. A construction deficiency generally results from poor inspection or a poor contractor, a contractor who will ride the edge of the specification and not give us our full measure of good aggregates, clean aggregates, and in general just deficient construction practices.

Mr. COURTNEY. Then you call that skimping on the job, isn't that it, or skimping on the specifications or the performance?

Colonel CONNER. Yes, sir.

Mr. COURTNEY. Is that right?

Colonel CONNER. It has been known to happen, yes, sir.

Mr. COURTNEY. Then, if you were asked to state a conclusion, an engineering conclusion, as to what these failures were, what the cause of the failure was in this instance, what specifically would you tell the committee was your reason?

Colonel CONNER. Not having the full report here with me, sir, I would rather the Corps of Engineers answer that from their report.

Mr. COURTNEY. All right. Let's pass that now.

Colonel CONNER. They make the report.

Mr. COURTNEY. Let's have the next runway or taxiway failure on which you base your conclusions.

Mr. HÉBERT. I think it would be a good time to recess now.

(Confers.)

Mr. HÉBERT. The committee will stand in recess until Wednesday at 10 o'clock.

Mr. FERRY. Sir——

Mr. HÉBERT. Yes. Mr. Ferry?

Mr. FERRY. I will be unable to attend due to a prior commitment with another subcommittee of the Armed Services. Will you excuse me, sir?

Mr. HÉBERT. All right.

Mr. MILLER. I would like to ask Mr. Ferry a question if you are going to adjourn until Wednesday.

Mr. HÉBERT. All right.

Mr. MILLER. Have you coordinated your studies with the CAB, who handle some of the design or pass upon the design of civilian airports?

Mr. FERRY. Colonel?

Colonel ALEXANDER. No, sir.

Mr. FERRY. No, sir.

Mr. MILLER. That is all.

Mr. HÉBERT. The committee will stand in recess until Wednesday at 10 o'clock.

(At 12 o'clock, noon, a recess was taken, to reconvene at 10 a. m. Wednesday, June 26, 1957.)

AIRSTRIP PAVING MATERIALS

WEDNESDAY, JUNE 26, 1957

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE FOR SPECIAL INVESTIGATIONS,
Washington, D. C.

The subcommittee met at 10 a. m., the Hon. F. Edward Hébert, chairman of the subcommittee, presiding, with the following members present: Mr. Hess, Mr. Gavin, Mr. Rivers, Mr. Cunningham, Mr. Bates, Mr. Hardy, Mr. Osmers, and Mr. Miller.

Mr. HÉBERT. The committee will be in order.

Mr. COURTNEY. Mr. Chairman, Colonel Conner has an addition to the record in answer to one of the questions that was addressed to him on Monday.

Colonel CONNER. Yes, sir; Mr. Chairman, during the hearing before your committee on June 24, 1957, the Air Force was questioned as to whether it had collaborated with CAB.

Be advised that to the best of our knowledge, the Air Force has never collaborated with CAB on airfield pavement problems or policies. On the other hand, there has been an exchange of information with other agencies such as CAA, the Transport Pilots Association, various commercial airport operators and airline operators, and in general the information which the Air Force passed on to these agencies was in the nature of answers to their queries regarding the Air Force experience with jet aircraft, pavement design, pavement policy, and so forth.

Mr. HÉBERT. Now Colonel, do you care to elaborate any more?

Colonel CONNER. No, sir.

Mr. HÉBERT. Anything further on your testimony of last Monday.

Mr. COURTNEY. I will ask him.

Mr. Chairman, on Monday when we recessed we were discussing Pinecastle Air Force Base, and the pavement failures there which the Colonel had addressed himself to, and we had concluded a discussion of March Air Force Base, as to which a failure was reported.

Those 2 bases are in a series of 8 that were mentioned by Mr. Ferry as cases in which failures had occurred on runways and were the basis or formed part of the basis for the engineering judgment for the changing criteria.

Now Colonel, I would like to ask you—I notice the record did not indicate at the point of my questioning the amount of the failure in dollars at March Field, and at Pinecastle. Do you recall that?

Colonel CONNER. Yes, sir.

Mr. COURTNEY. What was the amount of the failure in dollars at March?

Colonel CONNER. At March Field, $72,000 were required to rehabilitate the failed portion in the southeast 1 mile of runway.

Mr. COURTNEY. And at Pinecastle—I had not come to that question—What is the situation there?

Colonel CONNER. At Pinecastle, we have not a firm estimate on that. The closest estimate that we have for the expected rehabilitation of Pinecastle will be in the neighborhood of $250,000.

Mr. COURTNEY. Now, Colonel, with reference to the causes of the failures as far as your engineering information runs, do you have an explanation, an engineering judgment or information with respect to the cause of the failures and location of the failures as they would appear in the structures to which you have addressed yourself?

Colonel CONNER. Mr. Courtney, for the information of the committee, we would like to present some material in chart form that we have organized which will better explain the construction of flexible and rigid pavements, and the action of loads and stresses on those pavements.

May we have permission to present that material?

Mr. COURTNEY. That would be applicable to March as well as Pinecastle?

Colonel CONNER. Yes, sir.

Mr. COURTNEY. Will you then proceed in your own way?

Colonel CONNER. Thank you.

Colonel Alexander, will you explain the chart?

Colonel ALEXANDER. This chart shows comparative sections of rigid pavement, and flexible pavement.

Our main purpose is to try to clarify in everyone's mind just what goes into making up the two pavements so that we can discuss them as a total structure.

In this particular case, the pavement—the rigid pavement is designed with a K of 50. The "K" is an indicator of the bearing qualities of the soil. K of 50 is considered low.

In the flexible pavement, it is a comparative index, but we call it in this case a CBR, or California bearing ratio.

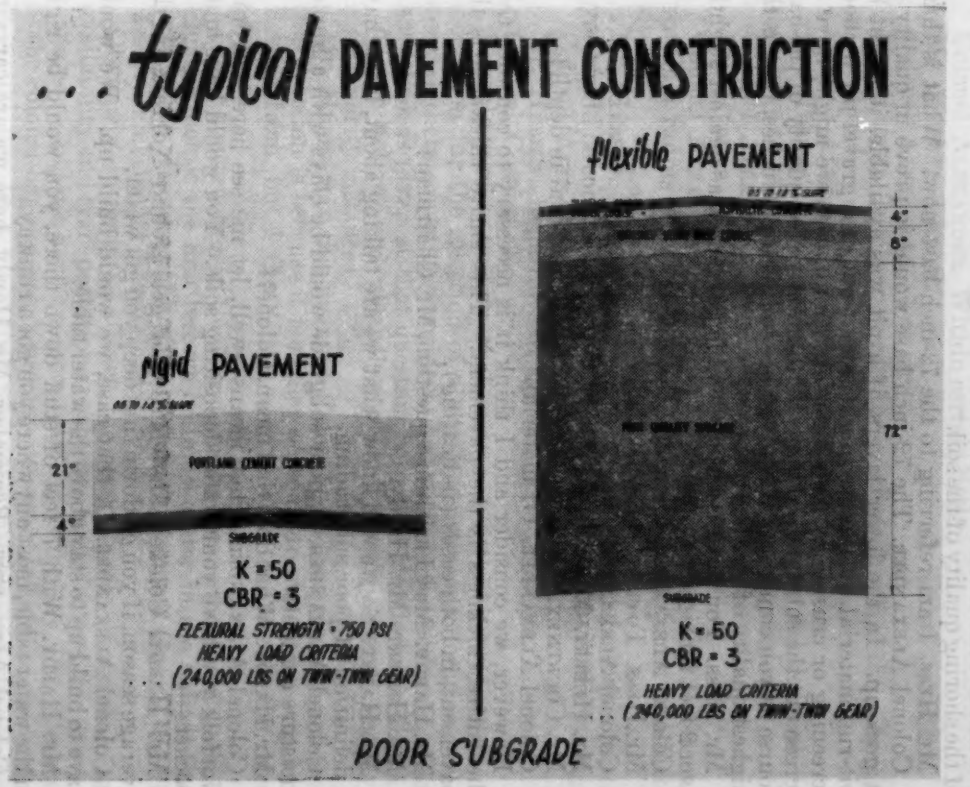
This indicates in both charts the total thickness of the two types of pavements.

Mr. COURTNEY. That is, you include the substructure at both of those?

Colonel ALEXANDER. The substructure beneath this and the K and the CBR are indicative of the strength of the substructure. The whole thickness of the pavement structure is based on the bearing quality of the substructure, and the type of traffic that will be imposed on the pavement. Notice in the case of the rigid pavement this has a thickness of portland cement concrete of 21 inches, and a high-quality subbase or filter course of 4 inches.

In the case of the flexible pavement, it is made up of a multiple of layers, starting out from the bottom of what we consider high-quality subbase.

That would be a total thickness of 72 inches. That would vary in quality as the layers are built up and compacted on the subgrade. On top of the high quality subbase will come a higher quality crushed stone base course. That is 8 inches. On top of that come 2 layers of asphaltic concrete, a total of 4 inches. They are made up of a binder course, and a surface course.


. . . typical PAVEMENT CONSTRUCTION
rigid PAVEMENT
21"
4"
SUBGRADE
K = 50
CBR = 3
FLEXURAL STRENGTH = 750 PSI
HEAVY LOAD CRITERIA
. . . (240,000 LBS ON TWIN-TWIN GEAR)
flexible PAVEMENT
4"
6"
72"
SUBGRADE
K = 50
CBR = 3
HEAVY LOAD CRITERIA
. . . (240,000 LBS ON TWIN-TWIN GEAR)
POOR SUBGRADE

Mr. HESS. Colonel, I am not quite clear on this. Do I understand you will have 7-foot thickness for the flexible pavement?

Colonel ALEXANDER. For this foundation condition, yes, sir.

Mr. HESS. What is the foundation composed of? Gravel?

Colonel ALEXANDER. No, sir. With a CBR of three——

Mr. HÉBERT. What is CBR?

Colonel ALEXANDER. California bearing ratio, and it is an index of the shoring quality of the soil.

Mr. HESS. I am referring to the 72-inch base now. What is that?

Colonel ALEXANDER. The 72-inch base would improve in quality as it goes up. In the lower layers, if a pit was available, it might be pit-run material, just as we might take it out of a gravel pit without screening or crushing. As we got higher up, then we might have to screen out the substandard material to improve the quality of the base course as you come up. When you get to this top 8 inches, that is the highest quality of crushed stone.

Mr. HESS. You have 7 feet of flexible pavement, as against slightly over 2 feet for rigid pavement.

Colonel ALEXANDER. 25 inches, yes, sir.

Mr. HESS. To carry the same load.

Colonel ALEXANDER. Yes.

Mr. HÉBERT. Mr. Courtney.

Mr. COURTNEY. You would have 7 feet of material in depth?

Colonel ALEXANDER. Of material.

However, we consider and I think it is necessary to consider that the entire thickness is the pavement. This entire thickness is the pavement, in both cases (indicating).

Mr. HARDY. May I ask him a question, Mr. Chairman?

Mr. HÉBERT. Mr. Hardy.

Mr. HARDY. So we will know what we are talking about, let us have a definition of poor subgrading.

Colonel ALEXANDER. A poor subgrade would be clays with a higher moisture content.

Mr. HARDY. What does that mean, Colonel?

Colonel ALEXANDER. That means—well, let me see here. Around Norfolk you have your water depositing soils. You would have mud-pockets——

Mr. HARDY. Colonel, anywhere you get around Norfolk in the average season, if you go down that deep you got water.

Colonel ALEXANDER. In that case, we would build up. We would have to build up to stay above the water table.

Mr. HARDY. With 7 feet of stuff down there, you would be right in the water table, most anywhere you got a runway.

Colonel ALEXANDER. Remember, Mr. Hardy, here we are carrying 240,000 pounds on twin-twin gear. Now, that means 240,000 on 4 tires. That is 60,000 pounds——

Mr. HARDY. Let me just ask you one question.

Colonel ALEXANDER. Yes.

Mr. HARDY. What is the elevation of Langley Field?

Colonel ALEXANDER. I don't know, sir.

Mr. HARDY. Mr. Chairman, I just wanted to get what he had to say about that.

Mr. HÉBERT. Let me ask about this subsurface situation. In selecting the site for airbases and airfields, the sites are selected according to their strategic location; is that right?

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. And you must accept the condition of the terrain or the soil or the subsurface conditions as you find them and build accordingly.

Colonel ALEXANDER. Within certain limits.

Mr. HÉBERT. I know.

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. In other words, the guiding factor is the geographical location?

Colonel ALEXANDER. That is correct.

Mr. HÉBERT. And having selected the geological location, you then have to resolve or meet the problem of soil conditions?

Colonel ALEXANDER. That is correct.

Mr. HÉBERT. Regardless of cost?

Colonel ALEXANDER. We attempt to get better sites. Normally, within a radius of, we will say, 100 miles you can find a satisfactory site.

Mr. HÉBERT. But not being able to find a satisfactory site, then you would be compelled to accept the situation as it exists?

Colonel ALEXANDER. That is correct.

Mr. HÉBERT. Regardless of the cost?

Colonel CONNER. No, sir.

I would like to qualify that answer a little bit. The first consideration for the selection of a site is its strategic location. However, if there are other considerations such as the economy, a long, hard look is given at that question before we decide to go ahead.

We do not proceed regardless of cost, except in some very, very high priority instances.

Mr. HÉBERT. In this instance, Colonel—and the reason I am asking this question is because it is rather personal to me, in the area where I come from, but I think it is a good idea to find out the overall program.

Under construction in the New Orleans area is the Alvin Callendar Field, which is the first reserve training center in the United States to be built. It is a combination of the Air National Guard, the Navy Reserve, and the Air Force Reserve.

Obviously, in order to attract, the reserve units in a certain area, availability and transportation are the two main factors.

So you could not have a reserve training center, say, 100 miles away, as the colonel has suggested, because you wouldn't get anybody there. It would just be a place that was not available and the reservists could not get there.

In the New Orleans area, Alvin Callendar site, the site of a previous airport, was selected, and there was a great deal of local comment because of the soil, that this was not a good site.

Yet, in the face of the cost it was selected. That is the type of problem I refer to. You couldn't control cost. You had to have the center. You had to have it available. And regardless of cost, you had to build it. That is what I meant.

Colonel CONNER. That qualifies under my statement, that certain fields because of their overriding priority are built no matter how much they cost.

Mr. HÉBERT. No matter how much they cost. So then the main and the most directing factor is the strategic locations for its mission; is that a correct statement?

Colonel CONNER. Yes, sir.

Mr. HÉBERT. Isn't that a factor?

Colonel CONNER. Yes, sir.

Colonel ALEXANDER. Mr. Chairman, I wanted to point out, though: the loading for this design is 240,000. It comes down to 60,000 pounds on one wheel. And that approximates the load of a railroad car, on many wheels, and on steel tracks, the crossties and many feet of high-grade ballast.

Mr. COURTNEY. Colonel, before you leave that, may I ask just two questions so the record will be clear. This, of course, is a hypothetical case.

Colonel ALEXANDER. On a poor subgrade.

Mr. COURTNEY. On a poor subgrade.

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. On a California bearing ratio of 3, which you consider very poor or likely to sink——

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. Under a weight load of this character.

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. It assumes an equal weight load on top, does it not, on both——

Colonel ALEXANDER. They are both designed for the same load.

Mr. COURTNEY. Yes. And it assumes a clean surface on which to build.

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. That is right.

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. At the point where you commence to show the fill or whatever you call it, above the line indicating subgrade.

Colonel ALEXANDER. Yes, sir, subbase.

Mr. COURTNEY. Of course, there is a difference in the cost of the materials regardless of the total volume; isn't that right?

Colonel ALEXANDER. Very much difference.

Mr. COURTNEY. Do you have any comparative figures on the cost of one design, material versus material, of the rigid type pavement?

Colonel ALEXANDER. We could give you those estimates. I don't have them available, but we could estimate per square yard——

Mr. COURTNEY. I notice you use 21 inches, for example, as an overlay on portland cement, in the illustration which you have used. I also observe that in the data which the subcommittee has, the general density of the rigid pavement is from 14 to 17 inches, the greatest depth I have observed. Is the 21-inch the new criteria?

Colonel ALEXANDER. I can best answer that by our new load design criteria published approximately a year ago.

When we published that criteria in collaboration with the Corps of Engineers, we devised 3 types of traffic for an airfield—A, B, and C.

The A traffic is known as channelized and that is the thickest.

The B traffic is next, and that is an intermediate.

The C traffic is the least-traveled portion of an airfield.

Now we have airfields—extreme case that I can recall at the moment is Amarillo and it runs up in the "A" traffic area to 27 inches.

Mr. COURTNEY. Of concrete?

Colonel ALEXANDER. Of concrete; yes, sir.

So the 21-inches merely is an indication of the same traffic for the two.

Mr. COURTNEY. Is this a fair question, before you pass it. Assuming the conditions that you are required to meet, the volume and character of material that appears on the righthand side of the chart for flexible pavement and the volume and character of material you show on the left side would be equal in performance, is that what you are trying to say?

Colonel ALEXANDER. Theoretically; yes, sir.

Mr. COURTNEY. Theoretically, it is equal.

So far as an engineering judgment is concerned, then, both those configurations and material would render an equal and a satisfactory service so far as engineering judgment is concerned?

Colonel ALEXANDER. That is the theory; yes, sir.

Mr. COURTNEY. And at that point, then, your confrontation would be the question of cost, isn't that right?

Colonel ALEXANDER. That is correct.

Mr. HARDY. Mr. Chairman, could I ask him a question?

Mr. HÉBERT. Mr. Hardy.

Mr. HARDY. How many runways do you have that are constructed and in use presently to the specification of each of those two?

Colonel ALEXANDER. I can't answer that, sir.

Mr. HARDY. Do you have any?

Colonel ALEXANDER. Yes, sir.

Mr. HARDY. Do you have any constructed to the specification that you have demonstrated here with respect to your flexible pavement?

Colonel ALEXANDER. I could cite you Limestone, which was built 7 or 8 years ago, and because of the frost condition, Mr. Hardy——

Mr. HARDY. That is not the same problem, though, Colonel.

Colonel ALEXANDER. Well——

Mr. HARDY. It wasn't done because of your bearing ratio, was it?

Colonel ALEXANDER. Only because when you have a frost condition your bearing ratio drops. So when you have frost going out of a soil you have an excess moisture, so your bearing condition does drop.

Mr. HARDY. Is Limestone built to that specification?

Colonel ALEXANDER. Not for 240,000; no, sir. It was 100,000 pounds.

Mr. HARDY. Does Limestone have that 72 inches of built-up subbase?

Colonel ALEXANDER. It has a little less. As I recall, it is in the area of 62 inches.

Mr. HARDY. So actually, you don't have any runways that are built for those specifications, with your flexible pavement?

Colonel ALEXANDER. I can't answer you definitely, Mr. Hardy. I could determine that——

Mr. HARDY. So it is just a theoretical proposition you have there?

Colonel ALEXANDER. Yes, sir.

Mr. HARDY. All right.

As long as we are talking about theory, just one other question. Your bearing ratio of your subgrade under the total of 25 inches, under the rigid pavement at that point—your bearing ratio there is supposed to be the equivalent of the bearing ratio over here at a distance of 7 feet?

Colonel ALEXANDER. That is correct.

The load is distributed in such a way, from this point to this point, and this point to this point, that it would be equal.

Mr. HARDY. Wait. Let's make one other assumption.

Colonel ALEXANDER. Yes, sir.

Mr. HARDY. If the bearing ratio at a position of 7 feet below grade, as in the case of your flexible pavement, is equal to the bearing ratio at a distance of 2 feet over on the other side, does it follow that you started off with the same type soil?

Colonel ALEXANDER. As I understand the question——

Mr. HARDY. What I am talking about is—you have gone down a distance of 7 feet in one case, and a distance of 2 feet in the other case.

Colonel ALEXANDER. I think I understand.

In most of these airfields, due to spread that is a great deal of cutting and filling. If we had a 7-foot section, it might be fill or it might be cut. And the bearing quality of the soil that would be under that would be taken or determined.

So in spite of the depth of the section in either case, to make a comparison you have to assume that they were the same, regardless of the depth of the two sections. Otherwise, we couldn't compare them.

Mr. HARDY. Well, the question that is in my mind now is whether you have a comparable situation. I don't know. Because if you start off with a pretty level field, your bearing quality at 2 feet below grade is going to be entirely different from what it is going to be 7 feet below the grade.

Colonel ALEXANDER. It could be.

Mr. RIVERS. Surely.

Colonel ALEXANDER. Yes; it could be or couldn't, either way.

Sometimes we have to strip off several feet of a field and waste it because it is unsuitable. And you might have better material, or it might be just the contrary. Soil is such an extremely varying material that even it varies from one end of the runway to the other.

Mr. HARDY. My point is simply this, if you start off with a particular field, a particular location, a particular soil condition, you are not going to have comparability as between your cut 2 feet deep and a cut 7 feet deep. That is the whole question that is in my mind. So, if you start with the same field, you can't compare these two, because your condition 7 feet below grade and 2 feet below grade are going to be different.

Colonel ALEXANDER. Well, I can't agree with you fully, sir. In some cases it will, and——

Mr. HARDY. I didn't expect you to agree with me fully, Colonel.

Colonel ALEXANDER. Yes.

Mr. HESS. Colonel, could you give us the comparable cost of the type of construction for flexible pavement, as you show on your chart here, and the cost for the rigid pavement?

Colonel ALEXANDER. We can furnish that to you, sir. I don't have it handy, but we can——

Mr. HESS. Offhand, would you say, which was the greater? Now, you are going down 7 feet with one, and the other one 25 inches.

Colonel ALEXANDER. I have another chart of good subgrade, Mr. Hess. Let me pull them both out.

Now, in talking about poor quality subgrade—that is the bottom chart.

Mr. HESS. Yes.

Colonel ALEXANDER. Normally, the portland cement concrete is competitive or is less expensive.

Mr. HESS. What is this?

Mr. COURTNEY. You mean with a poor subgrade?

Colonel ALEXANDER. With poor subgrade, normally portland cement concrete is more economical, in first cost. Now, when you come to this other chart, where you have a CBR of 30 and a K of 300, you will notice that the flexible pavement drops to a total thickness of 17 inches. You get a tremendous credit for a good subgrade with flexible pavement. Whereas, the portland cement concrete drops to 25 inches.

Mr. COURTNEY. Twenty-six inches difference between the two there.

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. The total.

Mr. MILLER. Two inches.

Colonel ALEXANDER. Two inches total.

Mr. HESS. Yes, I see.

Colonel ALEXANDER. In this case of a good subgrade, the flexible pavement is normally more economical, on first cost.

Mr. HÉBERT. Mr. Rivers?

Mr. RIVERS. Well, then, if you go down 7 feet on that other chart, the flexible pavement wouldn't be worth putting down anyway. It would cost you more to start with, and your maintenance. You always have more maintenance on flexible runways than you have on rigid.

Colonel ALEXANDER. That is correct.

Mr. RIVERS. Everybody knows that. I wanted to ask you awhile ago when Mr. Hardy was bringing it up. When you go down 7 feet in my part of the world—you might get into the water table, when you go down 2 or 3 feet.

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. And water is right in your face.

Colonel ALEXANDER. That is right.

Mr. RIVERS. So if you go down 7 feet in the part of the country I come from you will hit water every time. I don't know what you will have to do. You will have to go through a lot of sealing processes on the flexible.

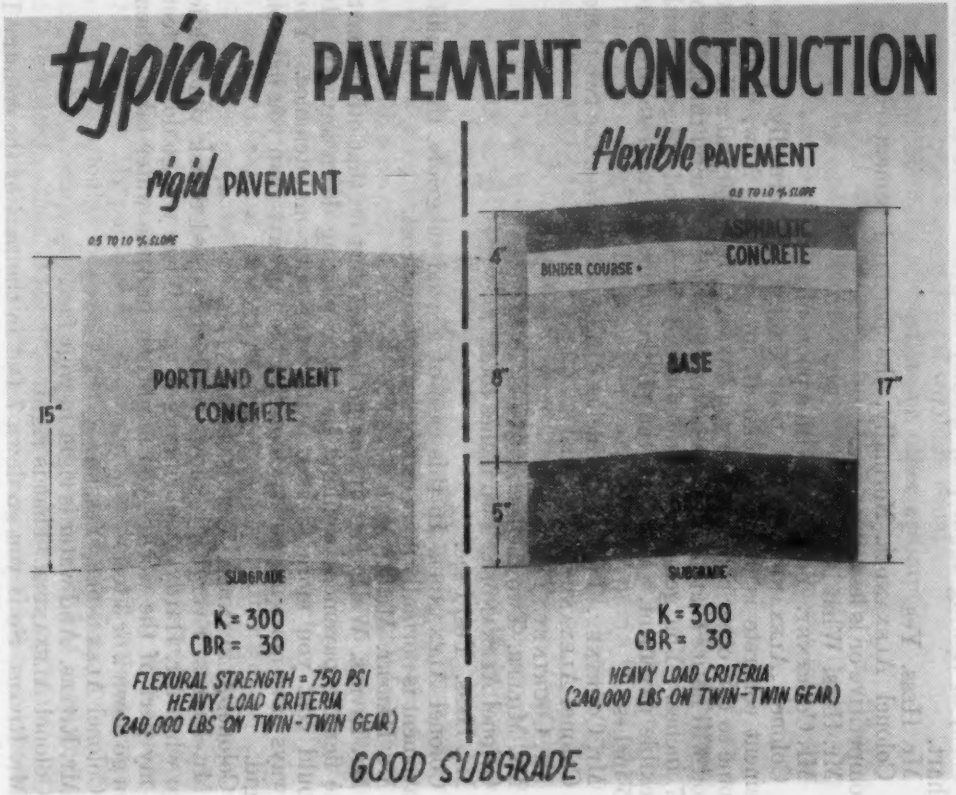
Colonel ALEXANDER. Either that or build up.

Mr. RIVERS. Build up, one of the two.

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. You couldn't go down. As Mr. Hardy says, you would have to start with a good subbase. You couldn't recommend a flexible pavement like that, could you?

Colonel ALEXANDER. No, sir.


typical PAVEMENT CONSTRUCTION
rigid PAVEMENT
0.5 TO 1.0 % SLOPE
15"
PORTLAND CEMENT CONCRETE
SUBGRADE
K = 300
CBR = 30
FLEXURAL STRENGTH = 750 PSI
HEAVY LOAD CRITERIA
(240,000 LBS ON TWIN-TWIN GEAR)
flexible PAVEMENT
0.5 TO 1.0 % SLOPE
4"
ASPHALTIC CONCRETE
BINDER COURSE
8"
BASE
5"
17"
SUBGRADE
K = 300
CBR = 30
HEAVY LOAD CRITERIA
(240,000 LBS ON TWIN-TWIN GEAR)
GOOD SUBGRADE

Mr. RIVERS. Seven feet.

Colonel ALEXANDER. No, sir. The Air Force feels that the portland cement concrete does your job.

Mr. RIVERS. On that analysis.

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. But on this analysis, you are different, is that right?

Colonel ALEXANDER. No, sir. This is still only for comparative purposes.

Mr. HÉBERT. Suppose you continued explaining this one now.

Mr. RIVERS. Yes.

Colonel ALEXANDER. All right, sir.

In this case, you know that the "K" is 300, as I mentioned and the "CBR" is 3.

The loading is 240,000 pounds. In this case the subbase is only 5 inches as contrasted to 72 inches.

Your crushed stone base course is still 8 inches, being identical with this section, and your asphaltic concrete is 4 inches which is made up of binder course and surface course. On the rigid pavement, the high-quality filter course is omitted and you end up with a 15-inch portland cement concrete slab.

Mr. COURTNEY. Two questions.

One. Comparing the flexible design which you have shown on the right-hand side, of the chart, and the rigid pavement on the opposite side of the chart, will each render the same service, an equal service?

Colonel ALEXANDER. It has not been our experience that that is true, Mr. Courtney.

Mr. COURTNEY. Then, why would you compare any designs which would not render equal service?

Colonel ALEXANDER. We do have cases, that is we have locations where it is necessary for us to build flexible pavement.

Mr. COURTNEY. But would you build a flexible pavement which was inadequate to do the service required of it?

Colonel ALEXANDER. We realize that we will have problems with the flexible pavement in these locations, but we also feel that the initial first cost and the location is such that it is the only thing we can construct.

Mr. COURTNEY. There is some point then in your thinking at which cost becomes a factor?

Colonel ALEXANDER. Yes, sir. Cost and construction time. The best example I can give you is on your Arctic bases where the construction season is so very short that we would not have the time to put in a concrete base.

Mr. COURTNEY. You have another factor there, too, and that is temperature, of course, for the laying of concrete, is that right?

Colonel ALEXANDER. Yes, sir.

Now, you can lay concrete——

Mr. COURTNEY. Let me ask you this now, before you pass this. Since these two designs are not comparable to do an equal service, would it be possible in the case that you pose now to design a flexible type pavement which would be comparable in service to the cement slab which you have shown?

Colonel ALEXANDER. We have—this is a point I think Colonel Conner would like to touch on.

Mr. COURTNEY. Well, whoever wants to answer the question.

Colonel ALEXANDER. That is on our investigational program. If you want to take that here?

Mr. COURTNEY. Are you ready for that now?

Colonel ALEXANDER. If you would like to go into that now?

Colonel CONNER. If we finished?

Mr. MILLER. Why did we have a 2-inch binder course in the good pavement and an 8-inch binder course in the other one? By the time you bring them up to that level aren't you supposed to have leveled off the differences?

Mr. HARDY. No.

(Further aside.)

Mr. MILLER. No, I didn't. This shows 4 and 8, or 12 inches down here. And 8-inch——

Colonel ALEXANDER. This is an 8-inch crushed stone base course.

Mr. MILLER. All right.

Colonel ALEXANDER. The binder and the surface makes up 4 inches on both charts.

Mr. RIVERS. Could I ask him a question before we leave this, Mr. Chairman?

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. Now 240,000—you are talking about a B–52?

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. The reason it is so fresh in my mind—I saw a picture of that B–52 last night. That is a mightly big airplane.

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. Now this question ought to go to the Army Engineers, but you are an engineer yourself?

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. And you think you are as good as they are, don't you? If you don't, you ought to—I imagine you are and I think you are good.

Colonel ALEXANDER. Thank you.

Mr. RIVERS. I think all of you are good. Can you envision a runway out of asphalt that you would be perfectuly satisfied with to use for a B–52 for an indefinite period of time?

Colonel ALEXANDER. No, sir.

Mr. RIVERS. You wouldn't feel safe on any kind of flexible runway for a B–52 for an indefinite period of time?

Colonel ALEXANDER. Our experience doesn't bear out that we would get a satisfactory pavement for an indefinite period of time.

Mr. RIVERS. You don't think we have arrived that far in our progress with asphalt?

Colonel ALEXANDER. That is correct.

Mr. RIVERS. Is that your statement?

Colonel ALEXANDER. Yes, sir.

Mr. GAVIN. Would the gentleman yield at that point?

Mr. RIVERS. I yield.

Mr. GAVIN. Yesterday you indicated that this flexible pavement was still in the experimental state and you were making a very intensive study of it at the present time. What progress have you made on that?

Colonel ALEXANDER. I would like to pass that to Colonel Conner, Mr. Gavin. That is in our investigational program.

Colonel CONNER. We have had a program going for the past 7 or 8 years. We have spent about $8 million in investigational engineering and research in furtherance of that program.

Mr. GAVIN. Who is handling that—you or the engineers?

Colonel CONNER. We are handling it through our construction agent, the Corps of Engineers, at their laboratory at Vicksburg, Miss. That has been one of the points that we have tried to bring out, that we are able in some cases to produce pretty good pavements in laboratories, but it is quite a different thing when it is produced by the contracting industry. You don't always get a good job. And we feel that the money that we are putting into these pavements—we can't take the chance on getting a substandard pavement.

Mr. GAVIN. Well, as far as you have gone now in your studies and research, you are satisfied that the flexible pavement is not the answer to the type of equipment we are flying today; is that right?

Colonel CONNER. At this point in time, yes, sir.

However, in this 1957 year we gave the Corps of Engineers approximately $700,000 to further experiment with rigid pavements in their laboratory in Cincinnati.

We had approximately the same amount staked out for them for the flexible laboratory. However, we only gave them about $400,000 for that experimentation. We felt at this time at least that there wasn't any use in further experimentation with the flexible pavements in light of our experience.

Mr. GAVIN. In other words, you spent about $8 million so far in your studies on flexible pavement, and they haven't come up with anything yet that satisfies you as being comparable to concrete, is that right?

Colonel CONNER. Yes, sir. And I might say further that I am not wholly convinced that there aren't more uses for asphaltic pavements and that I think we will further consider some additional experimentation with asphaltic pavements, because we have a lot of pavement down. We know that in the future we are going to build some more in certain places and I think it is incumbent on us to keep our technology current and try to see if there is not some way to build better asphaltic pavements.

Mr. GAVIN. Well, the studies you are making on the concrete—what are you finding out there?

Colonel CONNER. We are improving our design knowledge on concrete by putting down test sections, of reinforced and prestressed and post-tension sections, to see if we can't find some means to get this horrible 21-inch slab down within manageable and reasonable proportions, at lower cost.

Mr. GAVIN. Thank you, Mr. Rivers.

Mr. RIVERS. I wanted to ask you: You say you can't envision for any indefinite period of time, or say a reasonable time, that a flexible runway would be satisfactory for the 240,000 pounds.

What about the 47, the B–47?

Colonel ALEXANDER. I would say the same thing. It imposes a very similar load and approximately the same type of traffic. The gear configuration is very similar. So the actual wear and stress on the pavement would be very similar with both types of aircraft.

Mr. RIVERS. Because you have the same weight per wheel?

Colonel ALEXANDER. Approximately.

Mr. RIVERS. Why I asked you that: When we were down at Homestead, Fla.—Mr. Hardy was there—I noticed, myself, at Homestead, Fla., when we went down there on the housing—a place down there in the parking apron, I believe, where it looked like somebody had pushed it up like putty.

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. I don't know what caused that. But that was at Homestead, Fla. That is where they had——

Mr. HARDY. We thought that was blast damage, I believe, didn't we?

Mr. RIVERS. What?

Mr. HARDY. Blast damage, I think.

Colonel ALEXANDER. There has been some blast damage.

Mr. RIVERS. Parking, too.

Colonel ALEXANDER. There have been some steel shoe jacks on the pavement at Homestead.

Mr. RIVERS. That is why I wanted to ask you about both of those. Now you have your twin-twin gear there.

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. And on the 47 it is a little different?

Colonel ALEXANDER. It is twin gear.

Mr. RIVERS. So you may have the same weight per axle?

Colonel ALEXANDER. Per wheel, roughly.

Mr. RIVERS. Per wheel?

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. Colonel, a question right there. Your new criteria now specifies that the parking area will be of concrete, isn't that right?

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. What you were dealing with at Homestead was a condition that had previously existed without reference to the present criteria?

Colonel ALEXANDER. That is correct.

Mr. RIVERS. I think so. Mr. Courtney, I agree with you.

Mr. COURTNEY. Yes.

Mr. RIVERS. I think, too, there will come in—as I asked the other day and Mr. Ferry replied, too. Under your dispersal program you may have to redesign and rebuild a lot of these bases now for parking, under your new criteria.

Colonel CONNER. Yes.

Mr. HÉBERT. Colonel, will you proceed.

Colonel CONNER. I may add that in addition to this experimentation the Air Force felt like it was spending quite a little bit of money on research and development and we asked our Corps of Engineers to inquire of the asphalt industry if they were agreeable to sharing some of this experimentation cost with us and we would put some more money into it.

Their reply was that they were not interested in sharing this cost of further experimentation.

Mr. RIVERS. What about the concrete industry making a thinner slab over there? Did you ask them to help you on that, too?

Colonel CONNER. No, sir.

Mr. RIVERS. You want to get a thinner concrete slab, don't you?

Colonel CONNER. Yes, sir.

Mr. RIVERS. Why don't you ask the concrete industry to see if they will help you with the thinner slab? I think that would be fair.

Colonel CONNER. It would. However, both industries have been very helpful. The concrete industry furnished consultants to us in the United Kingdom, as well as the asphalt industry.

Mr. RIVERS. I think both of them are cooperating.

Colonel CONNER. We feel it should be a cooperative effort.

Mr. COURTNEY. Colonel, do you want to continue with your charts? I think there is another one there, isn't there?

Colonel ALEXANDER. Yes, sir. There is one other chart that showed the gear configuration of the aircraft. I don't know that there were any questions on this. But it does show the distribution of loading of our most up-to-date airplanes that have given us the most trouble. Of course the B–52, with the 4 wheels here and the 4 wheels here, and the B–47 with 2 and 2, are really the ones that impose the heaviest load.

Mr. RIVERS. What does a loaded KC–135 weigh, a loaded one? Because they are always loaded when they go off, aren't they?

Colonel ALEXANDER. Yes, sir. I believe it is 250,000 pounds. It would be approximately that.

Mr. RIVERS. They don't go off empty, not a KC–135.

Colonel ALEXANDER. That is correct.

Mr. COURTNEY. Colonel, in discussion of the weight load, the contribution of the weight load is not the same on all of the wheels is it?

Colonel ALEXANDER. No, sir.

Mr. COURTNEY. Let's take the B–52, which probably is the heaviest airplane unloaded, isn't it?

Coloned ALEXANDER. Yes, sir.

Mr. COURTNEY. Is that the one which you are designing for now?

Colonel ALEXANDER. That is the basis of our criteria. The forward gear carry approximately 48 percent of the load. The rear gear carry 52 percent.

So this is the worst condition, with this rear gear. These outrigger gears only carry a load when it is fully loaded and it may be on a turn and it may be wobbling slightly——

Mr. RIVERS. It varies.

Colonel ALEXANDER. The outrigger gear will take up the load.

Mr. COURTNEY. Your prime consideration is the principal landing gear?

Colonel ALEXANDER. Yes. To take the load of the outrigger gear, as Colonel Conner mentioned, we do use flexible pavement for our shoulder stabilization and that is built for 10,000 pounds per wheel load. That is along all of our taxiways.

Mr. COURTNEY. Now just while we are on that subject of weight, I want to be sure we have a full understanding of the extent of the problem.

CAA rates—according to my information—a loaded B–52 at 300,000 to 400,000 pounds.

Colonel ALEXANDER. That was the first model, sir.

Mr. COURTNEY. That was the first model. But the present model, in its present form, loaded and ready to take off for a business trip——

Colonel ALEXANDER. Is 456,000 pounds.

AIRCRAFT GEAR · Configurations
. . . USED AS A BASIS FOR DESIGNING AIRFIELD PAVEMENTS
125,000 lb. LOAD
TWIN TANDEM, TRICYCLE
KC-135
HEAVY LOAD DESIGN
1950 - 1956
PRESENT
25,000 lb. LOAD
SINGLE WHEEL, TRICYCLE (LIGHT LOAD DESIGN)
F-89
100,000 lb. LOAD
ON MAIN GEAR, TWIN BICYCLE
B-47
240,000 lb LOAD
ON MAIN GEAR, TWIN-TWIN BICYCLE (60,000 # ON EACH WHEEL)
B-52
79,000 lb. LOAD
ON EACH TWIN, TRICYCLE
KC-97
167,000 lb LOAD
ON EACH TWIN TANDEM, TRICYCLE
B-36

Mr. COURTNEY. Is 456,000 pounds?

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. And the design we are talking about here today: that is based on the distribution of that 456,000 pounds, 48 percent on the front gear and 52 on the rear gear?

Colonel ALEXANDER. That is correct.

Mr. COURTNEY. And that comes to what per wheel?

Colonel ALEXANDER. Roughly 60,000 pounds.

Mr. COURTNEY. At the maximum——

Colonel ALEXANDER. That is correct, on the rear 4 wheels.

Mr. COURTNEY. On the rear 4 wheels?

Colonel ALEXANDER. Right, sir.

Mr. COURTNEY. Now generally throughout this discussion we have been talking about a load of 100,000 pounds. Would that be considered a margin of safety?

Colonel ALEXANDER. No, sir. When you talk about 100,000 pounds, you are talking about that on 2 wheels. That was our criteria up until approximately a year ago.

Mr. COURTNEY. Then would we understand that the weight problem is decreasing?

Colonel ALEXANDER. Increasing, sir.

Mr. COURTNEY. Increasing because of the total load?

Colonel ALEXANDER. We have gone from 100,000 pounds——

Mr. COURTNEY. On 2 wheels?

Colonel ALEXANDER. On 2 wheels, to 240,000 pounds on 4 wheels.

Mr. COURTNEY. That so far as you know, Colonel, is your maximum requirement at the moment?

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. And for the immediate future?

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. Now as I understand it, the B–47 loaded, which is now in service, is somewhat less than the B–52. I think that is rated—CAA rates that loaded at 200,000 pounds.

Colonel ALEXANDER. It has increased slightly on later models.

Mr. COURTNEY. It would be well within the compass of the B–52 loaded?

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. Colonel, could I ask you on that wheel proposition? Now on the B–52 you have 60,000 pounds on each wheel?

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. How much do you have on each wheel on a KC–135—each wheel?

Colonel ALEXANDER. Approximately——

Mr. RIVERS. Loaded, I am talking about.

Colonel ALEXANDER. 31,000 pounds.

Mr. RIVERS. Loaded?

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. No.

Mr. RIVERS. Loaded?

Mr. HESS. It isn't loaded.

Mr. RIVERS. Not loaded.

Colonel ALEXANDER. Yes, sir, 125,000 pounds on twin tandem. Twin tandem is 4 wheels.

Mr. COURTNEY. Oh, yes, that is right.

Colonel ALEXANDER. Yes.

Mr. COURTNEY. All right.

Colonel ALEXANDER. Now there is another thing to consider here when you are talking about loads and tires and that is the contact area of the tire, which comes back to what is the tire pressures. That affects pavements very much.

The tire pressures on the B–52—they are now running close to 225 p. s. i.

Mr. COURTNEY. 225 pounds per square inch?

Colonel ALEXANDER. Pounds per square inch, yes, sir, as compared—I don't know what the tire pressure of the KC–135 is, but it is a commercial type aircraft and you find very few of those that will exceed 80 or 90 pounds per square inch. They maintain a softer tire to help the pavement problem. Also in the high performance aircraft, the high pressure tires are necessary to reduce the volume needed for the gear in the aircraft frame itself.

Mr. HÉBERT. Is that all of your presentation there, Colonel?

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. Now Colonel Conner, you have something further?

Colonel CONNER. I would ask Colonel Alexander if he would explain to the committee the way the loads are stressed from the top of the pavement, at the point of contact to the tire, into the subgrade.

Mr. HÉBERT. Colonel Alexander.

Colonel CONNER. It has a bearing on it.

Mr. COURTNEY. This is the second of the two charts that you have been using, so the record will be clear.

Colonel CONNER. It will be typical of any.

Mr. COURTNEY. I want the record to be clear.

Colonel ALEXANDER. As the load is imposed on here, the pavement structure is a means to distribute that load and reduce the pounds per square inch that come onto the natural soil of the subgrade. And it is evident, if you will reflect on it a minute, that the rigid type pavement has a greater characteristic of distribution of load for inches of thickness than does a flexible type pavement.

Mr. COURTNEY. Colonel, could you illustrate how the load is distributed downward, in any way, so we may have it graphically? You need a pencil?

Colonel ALEXANDER. Yes. I will draw right on these sketches.

Colonel CONNER. Turn it around and write on the back.

Colonel ALEXANDER. In the case of the rigid, the tire——

Mr. RIVERS. 60,000 pounds.

Colonel ALEXANDER. A load of 60,000 pounds. It will be spread down through, like this [indicating], through the pavement, and form a bulb of pressure——

Mr. COURTNEY. In the subgrade?

Colonel ALEXANDER. In the subgrade. It is of this order.

In the flexible pavement, the same load——

Mr. COURTNEY. Yes.

Colonel ALEXANDER. In your flexible pavement you get a similar bulb of pressure. It is necessary to make this thicker, so that when you reach the bottom of the pavement section your p. s. i.—that is pounds per square inch—right there and right here, will be the same.

So you have to make this, right here, thicker, to get that distribution, so you come down here and so your bulb will come out like this.

Going back to——

Mr. COURTNEY. That simply means there must be a greater volume of material, whatever it may be, between subgrade and surface on the flexible pavement versus the concrete pavement; is that right?

Colonel ALEXANDER. That is correct; to get the distribution of stress through the pavement structure.

Mr. COURTNEY. Then it becomes a question of volume and a question of cost in the distribution of weight?

Colonel ALEXANDER. Availability of aggregates as well; yes, sir.

Mr. COURTNEY. That is right.

Mr. HARDY. Your bulb on your flexible pavement is bigger; is that the idea?

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. What law are you quoting there? What law of physics or geometry or whatever you call it? What kind of law is that?

Colonel ALEXANDER. I don't know, unless it is Newton's law, that every action has an equal and opposite reaction.

I will have to refer this to my friends in the Corps of Engineers.

Mr. COURTNEY. Colonel, the illustration which you have given is a dead weight illustration; isn't that right?

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. What we are talking about here is runways. Is there a difference in the weight load as the plane moves across the runway?

Colonel ALEXANDER. As an aircraft moves out from its parking ramp and goes to the end of the runway, it is very close to these loadings, with the exception of any roughness—you begin to get a dynamic loading as you bounce, just as your automobile does on a corduroy road.

Mr. COURTNEY. We are not talking about corduroy, I hope.

Colonel ALEXANDER. No, sir, but we have it, Mr. Courtney. As it gets to the end of the runway and starts to takeoff—if any of you have seen the B–47's and B–52's take off, you will see their wings come from a drop position and they will come up. They are starting to take load and picking the aircraft off of the runway. The aircraft and the load——

Mr. COURTNEY. My question is simply this: The illustration which you have on the chart, of the bulb and the distribution through the various surfaces, is based on the dead weight illustration?

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. Am I to assume that that would be the maximum weight at any one point on the runway, and that as the plane takes off, or commences its movements, the weighted load becomes less?

Colonel ALEXANDER. That is correct.

Mr. COURTNEY. On the surface and on the subgrade?

Colonel ALEXANDER. That is correct.

Mr. OSMERS. Mr. Chairman.

Mr. HÉBERT. Mr. Osmers.

Mr. OSMERS. I think we are getting pretty far afield in the discussion here and getting into engineering and physics. We are getting

pretty far removed from whether modern heavy aircraft need rigid or asphalt runways.

Now, this matter has been heard in some detail before. Policies have been adopted. If the asphalt people feel that they have been unfairly dealt with, I think they ought to be able to come to this committee and present their case.

I would like very much to hear whether they question the actions that have been taken by the Air Force in connection with the construction of these runways for the fields, in order to handle these modern, heavy airplanes.

Mr. HÉBERT. Mr. Osmers, that is the whole purpose of the hearing. The Air Force has to present its case first, and tell us the reason, and inform the members of the committee as to their reasoning and their conclusions.

After they have done that, and the members of the committee are completely satisfied that they have a full knowledge of what the Air Force is talking about, then we will hear from the asphalt industry, and they shall have their day in court.

But until such time as the committee feels that it wants more information from the Air Force, I feel constrained to let the Air Force tell its own case, and let the members pursue it as long as they want to, as long as everybody understands everything on the Air Force side.

Mr. OSMERS. I certainly, Mr. Chairman, agree completely with you that the Air Force should be permitted to present its case. If someone makes a statement against the policy of the Air Force, I think then we should let them explain their position.

Mr. HÉBERT. Mr. Osmers, the whole hearing here is based on complaints that have been received. The prior committee, two sessions ago, under Mr. Hess, came into an agreement with the Air Force and the Department of Defense on the use of asphalt or flexible paving, as compared to concrete. That agreement was reached, and it was set aside by the Department of Defense. Then complaints have come to the committee from the asphalt people in connection with setting aside that agreement.

Mr. OSMERS. The asphalt industry has——

Mr. HÉBERT. Has complained. That is the reason they are here today.

Mr. OSMERS. They have complained?

Mr. HÉBERT. They have complained, and that is why we are here.

Mr. OSMERS. I haven't seen that complaint in writing, and I have an office in this building and no asphalt man has been up to make a complaint to me about it. I just haven't seen it, that is all.

Mr. HÉBERT. I will say this to you, Mr. Osmers. If you attended the committee meeting at the time it was authorized——

Mr. OSMERS. That was 2 years ago.

Mr. HÉBERT. I am talking about this year. Every meeting of this committee has been set with the authorization of the committee and not solely at the call of the Chair. This hearing today is the result of presentations made to this committee in executive session and the committee authorized the hearings. We are here because the asphalt people have complained.

Mr. HARDY. Mr. Chairman, may I make one observation about this? I think actually my friend from New Jersey will bear me out on this. We have another responsibility also with respect to this contention

as between asphalt and portland cement and that has to do with the cost, because we are concerned with cost.

Mr. HÉBERT. That is right.

Mr. HARDY. And we have a responsibility in that field.

Now if we can get—from an engineering point of view, if it can be shown that a cheaper asphaltic runway is just as serviceable, I think we would be derelict in our responsibilities——

Mr. GAVIN. Will the gentleman yield?

Mr. HARDY. I am through. Thank you.

Mr. HÉBERT. Mr. Hardy has certainly put his finger on the situation here, Mr. Osmers. It is our responsibility and that is the reason we are here. We are not here for an academic program or a discussion of engineering things, except as they are related in cost to the Government.

Mr. GAVIN. Let me interject at that point. Not alone cost—I am interested in cost, but I am interested in one thing that is of greater and paramount importance and that is human lives and safety. Costs mean little to me as far as these boys that are flying the planes are concerned. So let's not stress in this discussion that the greatest importance is cost, because I just don't view it in that way.

I am expressing my opinion so you will have my ideas as to why I am interested.

Mr. HÉBERT. I am sure your ideas fit into ours, Mr. Gavin.

Mr. OSMERS. I agree with that. May I just finish? May I say I think if the asphalt case would be presented first—and they certainly ought to have an opportunity to present it——

Mr. HÉBERT. They will have.

Mr. OSMERS. Then we would have some basis for hearing this testimony.

Mr. GAVIN. We are going to hear it.

Mr. HÉBERT. Mr. Osmers, it is a matter of presentation and the matter of presentation is in the hands of our capable and competent counsel, who arranged the agenda. This is the way it is to be presented, and the way it has always been presented.

Mr. RIVERS. Quite frequently Mr. Vinson just directs us to go into programs, too.

Mr. HÉBERT. That is correct.

Mr. GAVIN. Colonel, now you have given us an illustration of a B–52 loaded taking off. Now tell us what happens with a B–52 that is coming in, see, and possibly they don't make just a perfect landing. What is the situation when they don't come in where you have got an equalized load on the runway, and they are coming in with a terrific smash on that runway? They might have been hit, and they are not coming in perfectly. They are coming in way over from an equalized or perfect landing.

What happens to the pavement then?

Colonel ALEXANDER. Of course he has one safety factor in his tires. If he hits too hard, his tires will blow out. If he hits normally, or if he hits on one gear and the tires do not blow out, he is hitting so quickly—and also he is in a forward movement—that that does not stress the pavement excessively.

Mr. GAVIN. Will you repeat that? I can't hear you.

Colonel ALEXANDER. At the time the aircraft hits the surface of the pavement.

Mr. GAVIN. Yes.

Colonel ALEXANDER. He has a forward motion.

Mr. GAVIN. Yes.

Colonel ALEXANDER. In the order of 100 knots. If he hits hard, he is still going 100 knots forward.

Mr. GAVIN. Yes. But now he isn't hitting on all four's. He is hitting on one wheel—we will assume that. He is not making a perfect landing now. What is the stress on the pavement then?

Colonel ALEXANDER. Our experience is, Mr. Gavin, that he still does not exceed these loads that we designed for. He hits it so quickly, and he moves over it so quickly. It is just a very sudden impact, and the soil doesn't have time, or the pavement doesn't have time to react.

Mr. GAVIN. It doesn't?

Colonel ALEXANDER. It is over. Yes, sir.

Mr. GAVIN. It is hit and over?

Colonel ALEXANDER. Yes, sir.

Mr. GAVIN. But suppose he got into an area where you had flexible pavement, and weather conditions were extremely hot, and he hits on one wheel, what happens to that flexible pavement in comparison with concrete?

Colonel ALEXANDER. If the pavement is not properly constructed, I don't think there would be any more happen to it there than would happen to it on other parts of the field.

Mr. GAVIN. Would he get over it?

Colonel ALEXANDER. He would get over it too quickly.

Mr. OSMERS. What would his landing speed be, Colonel?

Colonel ALEXANDER. I don't know exactly. I would like to ask—just one second, sir. [Confers.]

It is 100 to 120 knots stall speed.

Mr. MILLER. Mr. Chairman.

Mr. HÉBERT. Mr. Miller.

Mr. MILLER. Colonel, getting back to these pressure bulbs or whatever you call them, in the final analysis they are both the same size, aren't they?

I think you said that one was bigger than the other. They are both designed to take a certain pressure that is coming from the plane.

Colonel ALEXANDER. Yes, sir.

Mr. MILLER. And your design—that is, the object of your design is to make these exactly the same?

Colonel ALEXANDER. That is correct.

Mr. MILLER. Or as near as you can the same.

Colonel ALEXANDER. You make them the same size by getting greater thickness here.

Mr. MILLER. Certainly.

Each of these now are strips 200 feet wide and 14,000 feet long. That is about it, isn't it?

Colonel ALEXANDER. Yes, sir.

Mr. MILLER. Over that period, if we put in this block of portland cement that far, and we don't use it at all—we just let it sit there—will there be any settlement or subsidence?

Colonel ALEXANDER. It is always possible, but for subsidence or settlement to occur there have to be some soft layers down in this subgrade somewhere.

And to make that move, there has to be a load imposed. Now sometimes the pavement structure itself will impose that load.

Mr. MILLER. Now between these two, if you go to the poorer subgrade, you would go out on this poorer subgrade and put in your 25 inches of concrete on your strip 14,000 feet long, there would be a good chance for subsidence there; would there not?

Colonel ALEXANDER. No, sir.

Mr. MILLER. If you just let it stand?

Colonel ALEXANDER. Not normally. I think I see what you are getting at. It is that the rigid pavement weighs more than the flexible pavement.

Mr. MILLER. No, I am going to say in both of them you have weight. You are putting weight on the poorer subgrade—poorer material in the subgrade, and you are putting in that much concrete. If you just put it out there and let it stand there, at the end of a year if you go and run levels over it, wouldn't you find there is certain subsidence, depending on the subgrade from good to poor, the degree of subsidence?

Colonel ALEXANDER. I think it will be negligible, Mr. Miller. I think it would be negligible. It would be so negligible it would be very hard to measure unless you had a very high order of accuracy with your levels.

Mr. MILLER. Well, we have some poor subgrade material, or conditions in the San Francisco Bay area, and you get subsidence. You get subsidence of highways. You build them up to a grade and you build them with all of these things, and just with time alone they go down, and go down faster, then you have to go in and keep rebuilding them until you reach the place where of course it is transmitted by fairly substantial amounts of grade down to the substantial soil beneath it.

Colonel ALEXANDER. That is possible.

Mr. MILLER. Not only possible, but doesn't it happen?

Colonel ALEXANDER. Yes, sir, it happens.

Mr. MILLER. If you go back and read some engineering data in the past century on such things as, for instance, railroad grades, which were comparable at their time——

Colonel ALEXANDER. Yes.

Mr. MILLER. Across the Suisun sink, you will find that you didn't beat that until down through this soft material you have substantially built a fill that got down to the hard rock.

Now won't the same thing take place here? You are not going to tell me, are you, that under a poor subgrade, because you put 25 inches of concrete strip 14,000 feet long and 200 feet wide, that it is going to remain as stabilized as if you never do another thing but just let it stay under its own weight on a poor subgrade?

Colonel ALEXANDER. No, sir, I don't say that.

Mr. MILLER. That is right.

Colonel ALEXANDER. Because it will subside.

Mr. MILLER. That is right. Then the other will subside too.

Colonel ALEXANDER. Yes, sir.

Mr. MILLER. When the concrete subsides in a place where that subsidence becomes great enough, it has to give someplace, and when it begins, it begins to go all over.

Colonel ALEXANDER. It will crack, and it will find its own level.

Mr. MILLER. It will find its own level, and that level, depending on where it happens—if there happens to be a rigid rock under it, will be up one place and may go down 8 inches in another.

Colonel ALEXANDER. That would be quite extreme; yes, sir.

Mr. MILLER. Let me take you out and show you some places.

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. Mr. Courtney.

Mr. MILLER. I would be glad to do it if we could get to go.

Mr. GAVIN. May I ask a question, just very briefly?

Do you know of any commercial air bases that have any flexible pavement—that is, big bases?

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. That answers the question.

Mr. GAVIN. How heavy aircraft land on them? What is the heaviest type of aircraft?

Colonel ALEXANDER. The Super Constellation and the DC–7, I believe, are the heaviest commercial aircraft operating at the present time.

Mr. MILLER. What do they say?

Mr. GAVIN. What do they report?

Colonel ALEXANDER. They are not having the same type of structural problem that we have. They do not have the high tire pressure. They don't have the same type gear as the B–47 and B–52.

We have our KC–97, which is the same as the Boeing Stratocruiser that Northwestern Airlines operates. That is our present tanker aircraft.

We have had channelization from that type of gear, which is the typical tricycle gear.

The B–36 has a typical gear which in some respects is similar to commercial aircraft. But in both cases they have a little bit higher tire pressure.

I am sure that the commercial traffic must approach the same frequency of coverage, but I think the tire pressures are probably the key, that they are not having as much trouble as we are.

Mr. MILLER. Would the gentleman yield? I would just like him to clear up this tire pressure.

Mr. GAVIN. Yes.

Mr. MILLER. When you have a high tire pressure, you are putting a heavier concentrated load at a point, aren't you?

Colonel ALEXANDER. Yes, sir.

Mr. MILLER. If you have a low tire pressure, you are spreading that load?

Colonel ALEXANDER. Yes, sir; That is correct.

Mr. MILLER. So that is the difference.

Colonel ALEXANDER. Yes, sir.

Mr. MILLER. I just wanted to get that clear.

Mr. HÉBERT. Fine. It is clear now.

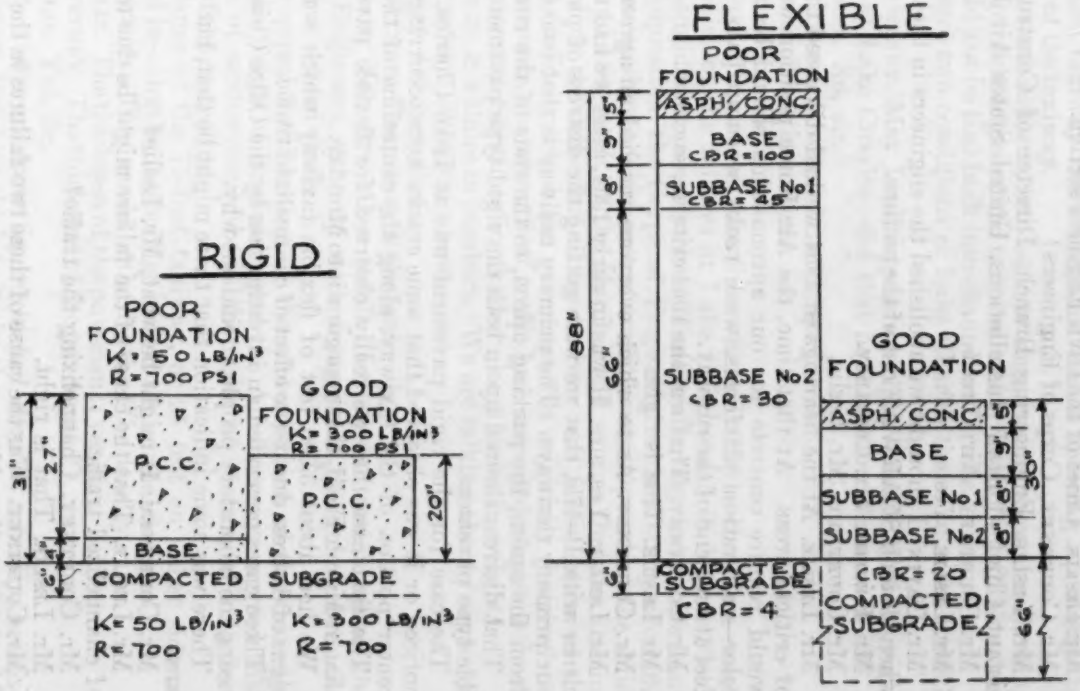
Mr. MILLER. I don't know that it is, but it is a little clearer on that point.

Mr. COURTNEY. Finish with your charts, Colonel.

Colonel CONNER. Sir, we have one more short chart that shows a brief history of what brought us to our current position of requiring total concrete.

(The chart mentioned above is as follows:)

TYPICAL AIRFIELD PAVEMENT SECTIONS FOR CHANNELIZED TRAFFIC AREAS



Colonel CONNER. Mr. Leslie, will you come up?

Mr. HÉBERT. Your name for the record, Mr. Leslie?

Mr. LESLIE. George W. Leslie.

Mr. COURTNEY. George W. Leslie.

And your official position?

Mr. LESLIE. Chief of the Civil Engineer section.

Mr. COURTNEY. Corps of Engineers?

Mr. LESLIE. Engineering Branch, Director of Construction, Assistant Chief of Staff, Installations, United States Air Force.

Mr. COURTNEY. Air Force?

Mr. LESLIE. Yes.

Mr. GAVIN. I thought we abolished the engineers in the Air Force, when we took SCARWAF out of the picture.

Mr. HÉBERT. Mr. Courtney.

Mr. COURTNEY. Mr. Leslie.

Mr. LESLIE. At the hearings of 1954 we had discussed the problem of critical areas. At that time, the Air Force position was that we would require concrete for our aprons—this should be a different color—calibration platforms, wash racks, warmup pads, and 1,000 feet at each end of the runway.

Mr. COURTNEY. That was the 1954 criteria, so-called.

Mr. LESLIE. That is right.

Mr. COURTNEY. As to which everyone reached an agreement.

Mr. LESLIE. Yes, sir. It was in early 1954, after we had some experience with B–47's, that we were getting the distress of pavement on our primary taxiways. The primary taxiway is that connecting link from the apron, the parking apron, to the ends of the runways.

That distress showed up in both the rigid type pavement and flexible type pavement.

The case for the rigid pavement was at Lake Charles, where we noticed or it was observed that some cracks were occurring along the center portion of the taxiway, along the centerline of the taxiway.

The first case that we really observed for flexible pavement was that at March Field, that was gone into Monday.

We had about 3,000 feet of flexible taxiway which was showing signs of distress due to the effect of channelized traffic.

These cases generated an investigation by the Office Chief of Engineers, the laboratory people, to find out why.

There was some indication that there might be that, but we weren't sure.

Mr. COURTNEY. It might be what, Mr. Leslie?

Mr. LESLIE. That the cause of the failure might be due to the effect of channelized traffic.

Mr. COURTNEY. Channelizing the traffic?

Mr. LESLIE. That is right.

Mr. COURTNEY. Was the cause of these two failures in the two places that you mentioned?

Mr. GAVIN. Where was that on the field?

Mr. LESLIE. Unfortunately, this is an ideal situation, Mr. Gavin. It doesn't represent the true layout at either Lake Charles or at March Field. But at March Field—I assume this is the south end of the runway—we had a taxiway that came out in this direction, and then took off at an angle something like this [indicating], to connect with the end of the runway.

It was in this portion of the taxiway where the distress was showing up.

At Lake Charles the runway runs in a northwest-southeast direction, I believe. It is not important. But we have a long taxiway that parallels that. It is a rigid pavement. Approximately halfway that long parallel taxiway there are some cracks showing up along the centerline of the taxiway.

There is some concern, too, because some cracks were also showing up on the outside edges of the taxiway which we did not think at the time—could not be tied back into channelized traffic.

There were two conditions at Lake Charles that had to be investigated.

Mr. COURTNEY. May I ask a question right there? Was the rigid pavement at Lake Charles—did that have reinforcing bars in it?

Mr. LESLIE. No, sir.

Mr. COURTNEY. It was solid concrete?

Mr. LESLIE. That is correct.

Mr. COURTNEY. Go ahead.

Mr. LESLIE. It is about that time—in early 1954—that as a result of the studies of the failures at Lake Charles and at March Field, and the thought that possibly channelized traffic may have some bearing on the question, the Corps of Engineers made a study of traffic distribution, to show the amount of traffic being imposed on the solid. It was found as a result of the March Field studies that the amount of traffic along the centerline of the taxiway was far in excess of the amount of traffic for which the pavement was originally designed.

In other words, the amount of traffic had increased almost 6 times.

Mr. COURTNEY. Six times in numbers, or 6 times in weight?

Mr. LESLIE. Six times in numbers. We are talking about frequency.

Mr. COURTNEY. Frequency now.

Mr. LESLIE. Of operation.

Mr. COURTNEY. Frequency is the issue.

Mr. LESLIE. Yes, sir. As a result of that, our design agent, the Corps of Engineers, came up with a suggested design to solve the effect of channelized traffic.

They proposed a thickening of the center section of the taxiway. Between the Corps of Engineers and the Air Force, we agreed that this width of section would be in the order of 25 feet, or 12½ feet each side of the centerline.

The balance of the 75-foot taxiway, or 25 feet on either side of that, would be—that is; it would go back to the normal design.

Mr. COURTNEY. That would be the depth of the density.

Mr. LESLIE. The thickness of the pavement; yes, sir.

Mr. COURTNEY. The thickness of the pavement.

Mr. LESLIE. Yes, sir.

In effect—there are some figures kicked around, actually, because we didn't know just how thick to make the center section, but it was indicated that based on past investigations somewhere between 10 and 20 percent additional thickness would be required.

Because we had no definite solution for channelized traffic on flexible pavements and we were more willing to take a chance to the suggested design for rigid pavements because of inherent stronger characteristics, we asked authority from the Office, Secretary of Defense, to use

rigid pavements solely for primary taxiway, pending further investigations of the flexible design.

That authority was granted, but with the stipulation that we would proceed with an investigation right then, of the design for both rigid pavement and flexible pavement.

I am talking about the channelized designs.

Mr. COURTNEY. That is for the primary taxiways?

Mr. LESLIE. That is right, sir.

In the meantime there were indications of channelized traffic on interior portions of runways—this section here. One of the first to occur was that at Pinecastle. That was ultimately investigated.

We also had cases of channelized traffic on another primary taxiway, at Davis Monthan. That was a flexible-type pavement.

There were also indications of distress of channelized traffic on flexible pavement on the apron at Altus.

With that background, we went ahead, and proceeded with the investigation by the Corps of Engineers on the channelized design for rigid pavement, and for flexible pavement.

In the meantime, we asked that a test section—an actual field condition, I mean—be established to actually build under normal contractual procedures and actual field conditions, with normal inspection procedures. We selected Kelly Air Force Base, at San Antonio, Tex., as the site.

This is only one phase of this broad investigation for the study of the channelized traffic designs.

That study actually would take a year. We recognized that.

In the meantime, we didn't know just which way to turn as far as flexible pavement designs go.

Consequently, because we didn't have a sure design and we didn't want to take the chance with the new construction program coming up, we asked authority to go to all concrete on——

Mr. COURTNEY. The primary taxiways?

Mr. LESLIE. The primary taxiways and the interior of the runway.

Actually—well, first of all, the primary taxiways, where we asked for all concrete.

Subsequently, after examining the distresses that were occurring in flexible type pavements, and without a sure design yet, and in view of the results——

Mr. COURTNEY. When you speak of a sure design, are you speaking of a sure design for rigid or flexible pavement?

Mr. LESLIE. We weren't sure of an approved design for rigid pavement.

Mr. COURTNEY. That was the uncertainty. Do I understand you resolved the plan as to rigid pavement?

Mr. LESLIE. That is right.

Consequently, that is when we asked authority to construct our primary pavements including taxiways and interior runways of rigid pavement.

Mr. HARDY. May I ask a question right there?

Mr. HÉBERT. Yes, Mr. Hardy.

Mr. HARDY. When did you become sure that you had a proper design for rigid pavement? I didn't get that. I thought you were still doubtful about that.

Mr. LESLIE. It is inherent in the characteristics of portland cement concrete, Mr. Hardy. It is just naturally stronger. There is less chance to go wrong in building a slab of concrete than there is in building a multiple-layer system such as flexible pavement.

Mr. HARDY. Now, you have had your experience of observing failures in both flexible and rigid, and your flexible at Lake Charles I believe——

Mr. LESLIE. Rigid pavement, sir.

Mr. HARDY. Rigid at Lakes Charles, and your flexible at March. Both of them broke down.

Mr. LESLIE. No, sir. Lake Charles did not break down.

Mr. HARDY. It cracked, you said?

Mr. LESLIE. It had some cracks. In the slabcracks, we call that a failure. But that doesn't put the taxiway out of commission.

Mr. HARDY. Then let me change my word. Eliminate "breakdown"; strike that out. Let's say, you had a failure. I don't know how serious that was, but you had a failure. So you made an assumption that you had corrected it by changing design. Did you have anything really to support your finding that you had come up with a proper design or a satisfactory design with respect to rigid? You haven't proved it yet, have you?

Mr. LESLIE. We are pretty well sure that we have; yes, sir.

Mr. HARDY. When? That is all I wanted to find out?

Mr. LESLIE. The Kelly test track was the one that really proved it out. We had two panels. One was rigid pavement, and one was flexible pavement.

Mr. GAVIN. But you didn't tell us that. You had two types at that experimental test track.

Mr. LESLIE. I am sorry, sir, I thought we brought that out Monday.

Mr. HESS. It was brought out Monday.

Mr. HARDY. You had both a rigid and flexible on your Kelly test track. Did that prove that your rigid would stand it, and at the same time your flexible would not?

Mr. LESLIE. Yes, sir.

Mr. RIVERS. Could I ask him a question there, Mr. Chairman?

Mr. HÉBERT. Are you finished, Mr. Hardy?

Mr. HARDY. Yes.

Mr. HÉBERT. All right, Mr. Rivers.

Mr. RIVERS. I think you made the statement that you asked for permission to proceed for constructing a rigid pavement for your inner runway.

Mr. LESLIE. Yes, sir.

Mr. RIVERS. That is the inside, away from the ends there. Of rigid construction.

Mr. LESLIE. We asked specifically to construct our primary use pavements of rigid pavement.

Mr. RIVERS. All right.

Mr. LESLIE. That included our primary taxiways, the runway ends.

Mr. RIVERS. The runway ends.

Mr. LESLIE. And interior portions of the runway, our warmup pads which were already agreed upon. The only addition was the interior portion of the runway and the primary taxiways.

Mr. RIVERS. Because you felt as a result of the Kelly tests that you had come up with something that was satisfactory.

Mr. LESLIE. Yes, sir.

Mr. RIVERS. I would like for the record to show what the thickness of that was.

Mr. LESLIE. The Kelly track?

Mr. RIVERS. Of the one that you came up with that you thought was going to solve your problems. It had to have some thickness, didn't it, a minimum?

Mr. LESLIE. Oh, yes, sir.

Mr. RIVERS. What was that?

Mr. LESLIE. I don't know, offhand.

Mr. RIVERS. Because if there is any doubt about it, you would just make it a little thicker, wouldn't you? I just wanted to know what your findings were. Because I could build a concrete that would stand up. If there was any question in my mind, I would do like the Germans did when they put those submarines in those sheds. I saw those sheds. They were so thick a bomb couldn't go through them.

Mr. LESLIE. Mr. Rivers, I would like to hold our discussion on the design and the results of the Kelly track for the office, Chief of Engineers representatives.

Mr. RIVERS. I just wanted to be certain. Here is my point, I just wanted to be certain that you didn't have a blank check to build it as thick as you please, so you were foolproof.

Mr. LESLIE. No, sir. Both designs were based on the best available data and information that we had at the time for 100,000-pound design load.

Mr. RIVERS. On the minimum thickness.

Mr. LESLIE. That is right, sir.

Mr. HÉBERT. May I ask this question in connection with the Kelly test: Do I understand your testimony is that you drew your conclusions as a result of the Kelly test?

Mr. LESLIE. Partially.

Mr. HÉBERT. That is what I wanted to find out.

Mr. HARDY. That doesn't answer what he said to me awhile ago.

Mr. HÉBERT. No.

Mr. RIVERS. No.

Mr. HÉBERT. I want to find out. You said you came to the conclusion after the Kelly test. Now, just what factor was the Kelly test in your conclusions, and what other factors were involved when you came to this conclusion?

Mr. LESLIE. At the same time, the Kelly test was being constructed, the investigations were being made both at the rigid pavement laboratory in Cincinnati and the flexible pavement laboratory at Vicksburg.

There are indications, then, based on, as I say, past experience, extrapolation of curves, field investigations, that—we were pretty sure that the concrete design would be able to stand up much better than the flexible design.

Mr. HÉBERT. And added to that were the results of the Kelly test.

Mr. LESLIE. Yes, sir.

Mr. HÉBERT. Now, as I understand, the Kelly tests, they were originated in order to prove up the competence of the rigid to the nonrigid——

Mr. LESLIE. For comparable design loads that we had available at the time, yes, sir.

Mr. RIVERS. That was a practical application of the laboratory work; is that right?

Mr. LESLIE. That is right.

Mr. HÉBERT. That is the laboratory you refer to at Vicksburg and other places, which were precedent to the Kelly tests?

Mr. LESLIE. That is right.

Mr. HÉBERT. So then the Kelly test would have to be the final conclusion?

Mr. LESLIE. It proved only that under those conditions the 100,000 design load worked as it did. We don't know—at least, we haven't finished our studies yet on the effects, the design for the 240,000 pound load.

Mr. HÉBERT. No, we are talking about what you have now. In other words, let's get it in our line of thinking. Of course, the laboratory work originated first.

Mr. LESLIE. Yes, sir.

Mr. HÉBERT. And you applied the laboratory work to the Kelly test in practice.

Mr. LESLIE. Yes, sir.

Mr. HÉBERT. And drew your conclusion from the Kelly test.

Mr. LESLIE. Partially, yes, sir.

Mr. HÉBERT. I get confused on "partially," too.

Mr. LESLIE. Actually, they worked hand in hand.

Mr. HÉBERT. All right, they worked hand in hand. Where was the conclusion? Was that an equal test, the Kelly test? That is, was it an equal test between the rigid and the nonrigid?

Mr. LESLIE. Yes, sir. As I say, both types of pavement, the rigid pavement, and the flexible pavement itself, sections——

Mr. HÉBERT. And they were both subjected to the same tests for which they were constructed.

Mr. LESLIE. Yes, sir.

Mr. HÉBERT. The loads weren't increased.

Mr. LESLIE. No, sir.

Mr. FERRY. I wonder, sir, if I could clarify that?

Mr. HÉBERT. Yes, Mr. Ferry.

Mr. FERRY. The test was made by erecting a continuous strip of paving, one half of which—the righthand side of it was flexible paying, and the lefthand side portland cement.

We started a loaded carriage with wheels simulating the spacing of a B–47, loaded with cast iron weights to bring the weight equal to the weight on the wheels of a B–47, and we took a tractor and we towed it from one end of the strip to the other end of the strip, back and forth, back and forth, day and night.

The results of that test indicated to us that our experimental work was confirmed, that the concrete was standing up as per design to do the job that we expected it to do, where the flexible did not stand up.

Mr. HÉBERT. In other words, your two strips were so constructed as to take the weight, what your engineers thought would take the weight of the B–47.

Mr. FERRY. That is right.

Mr. HÉBERT. All the strength was given to the flexible that you could possibly give to it to withstand the weight of the B–47?

Mr. FERRY. The design, sir, of this—and I will ask later that our Corps of Engineers confirm this. The design was the best known design information available to our design agents, to provide an economical pavement, both flexible and rigid, which would stand the weight equally well.

Mr. HÉBERT. The reason I pause to labor that question is because as I understand it, it is that test which is being challenged.

Mr. FERRY. There are questions, sir, that have been raised about it.

Mr. HÉBERT. That is correct.

Mr. FERRY. It is one of them.

Mr. HÉBERT. That is correct. That is the test that is being challenged.

Mr. FERRY. Right.

Mr. HÉBERT. Therefore, I want to know specifically and definitely if the designs were made for both the flexible and the rigid pavement to take the full load of a B–47 as far as——

Mr. FERRY. I am going to refer that question to my expert here, sir, because I did not look at the design data.

Mr. HÉBERT. In other words, you got the full capacity.

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. The maximum capacity out of the flexible test to take the 1947, or that you thought could take it, as compared to the full maximum of the rigid?

Colonel ALEXANDER. That is correct.

Mr. HÉBERT. And in the tests, the flexible did not take it?

Colonel ALEXANDER. That is correct.

Mr. HÉBERT. That is all I wanted to know.

Mr. HARDY. Could I just follow that up?

Mr. HÉBERT. Yes, sir.

Mr. HARDY. In your design, that is based on that test, are you using the same specifications for the concrete slab that you used in that test?

Colonel ALEXANDER. I think the Corps of Engineers should answer that, Mr. Hardy, because they design our pavements.

Mr. HARDY. I don't care who designed them. You have just been discussing two different thicknesses of rigid concrete slab, one 15, and one 21 inches, based on the subgrade that you had.

Colonel ALEXANDER. Yes, sir.

Mr. HARDY. Now, the only question that I want to know is whether those are comparable to the slabs that you used on your test. Did you use a 21-inch slab or did you use a 15-inch slab or did you use neither?

Colonel ALEXANDER. To the best of my knowledge, it was a 17-inch slab. That would have to be confirmed.

Mr. HARDY. And are you using that same criteria for similar subsoils now?

Colonel ALEXANDER. Yes, sir.

Mr. HARDY. All right. That is what I wanted to know.

Mr. COURTNEY. What did the Kelly test prove about varying subgrade or subsoil conditions?

Mr. LESLIE. Well, the subgrade is developed to the same strength for both rigid and flexible sections.

Mr. COURTNEY. No. But what did it prove about meeting various subsoil conditions such as you would meet in a variety of airfields over the different portions of this country?

Mr. LESLIE. It proved in that case that the design which was based on the subgrade bearing value was adequate.

Mr. COURTNEY. Well, did it prove——

Mr. LESLIE. For Kelly Air Force Base.

Mr. COURTNEY. Let me simplify the question. Did it prove anything more than that the design which you employed at Kelly as suitable for the subgrade and the subsoil conditions which you had to meet there?

Mr. LESLIE. Yes, sir.

Mr. COURTNEY. What else did it prove?

Mr. LESLIE. It proved that the assumptions made in developing the design for channelized traffic were adequate for the rigid pavement.

Mr. COURTNEY. For rigid pavement?

Mr. LESLIE. Yes, sir.

Mr. GAVIN. You did say, Colonel, that the studies are being continued to try to perfect the flexible type of pavement; is that so?

Colonel CONNER. Yes, sir.

Mr. GAVIN. Who is handling that? The Engineers, Department of the Army?

Colonel CONNER. Yes, sir.

Mr. GAVIN. Well, no doubt, they will come up with the proper answer.

Just leave it to them and they will give you a flexible pavement before they get through that will meet with the rigid, I am satisfied.

Colonel CONNER. All right, sir.

Mr. BATES. How much damage was done to the asphalt in the Kelly test?

Mr. LESLIE. I don't have—we don't have the final report on the Kelly test track, Mr. Bates.

When I was down there, there was what could be described briefly as a shoving of the asphaltic concrete to the side. There was about an inch, an inch and a half depression.

Mr. BATES. What was the cost differential originally between the two?

Do you have those figures?

Mr. LESLIE. No, sir, I don't have the cost figures on that.

Mr. BATES. Well, could you have repaired the asphalt portion of this field?

Mr. LESLIE. We could have made a stab at replacing the surface on the binder courses.

Mr. BATES. Would the cost of that be any greater than the original differential between the two?

Mr. LESLIE. No, sir, it would not.

Colonel CONNOR. We don't know.

Mr. FERRY. We don't know what it is.

Mr. LESLIE. I am saying this, that just replacing the surface and binder courses of the asphalt certainly would be less than the cost of the original pavement.

Mr. BATES. That is not the question. You had an original differential between the concrete and the asphalt. That is correct, isn't it?

Mr. LESLIE. Yes, sir.

Mr. BATES. Now, would the cost of repairing the asphalt be more than the differential that you originally paid for the concrete?

Mr. LESLIE. I don't know, sir.

Mr. BATES. Well, could you have repaired it so that it would be usable?

Mr. LESLIE. We could have made a temporary repair. I wouldn't say that it would have stood up under the continuous traffic for another 5, 10, or 15 years.

Mr. BATES. Well, I always thought we assumed here that there would be a higher cost of maintenance for asphalt. The question has always been whether or not that differential would be taken into consideration and balancing the two things off over a period of time.

Mr. HÉBERT. Your answer to Mr. Bates is you don't know, Mr. Leslie?

Mr. LESLIE. In the case of the Kelly test track, I believe that over a period of time, the amount of effort spent on making temporary repairs would soon eat up the original cost of the pavement.

Mr. HÉBERT. Well, can you make that as a definite statement? Mr. Bates has pointed out that that is the crux of the situation.

Mr. Ferry, can you answer that? That is what we are trying to find out.

Mr. FERRY. No, sir; because the Kelly test was not designed in any way as a cost differential, that is ascertaining cost differential either as to first cost or for repairs.

It was purely an experimental track, laid down to establish the criteria on which we would have to build pavements that would stand up without at that time making an assessment of the cost of the two pieces.

Mr. HÉBERT. In other words, it was merely a test of material.

Mr. FERRY. That is correct, sir. A test of material and construction methods.

Mr. BATES. Has there ever been any question that concrete would hold up better than asphalt?

Mr. FERRY. No, sir. We were trying to find an equivalent to the concrete that would stand up continuously, so as to give us as continuous usage of the field as concrete.

Mr. BATES. Is there any information available on the cost aspects of this test?

Mr. FERRY. There is not, sir.

There was no figures made as to costs in this test. The test was directed to other purposes.

Mr. HÉBERT. Mr. Osmers.

Mr. OSMERS. Mr. Chairman, referring to page 5 of the statement which Mr. Ferry made to the committee there is a list of comparative costs, unit costs there, and I notice that with the exception of the most recent period, from March 1956 to April 1957, the flexible pavements are very much less in cost than are the heavy load rigid pavement. Now, I would like to ask two questions about the Kelly test. First, was the thickness of the flexible and the thickness of the rigid pavement, in the designs that were used there, established by the Air Force or by, shall we say, the portland cement people on the one hand, and the asphalt people on the other?

Colonel CONNER. Briefly, Mr. Osmers, we gave the Corps of Engineers the criteria limits of loads that we wanted tested there. They were responsible for the design from which the thickness was——

Mr. OSMERS. It was the Government design?

Colonel CONNER. The Corps of Engineers design.

Mr. OSMERS. In other words, it was not an industry standard that was given to you?

Colonel CONNER. What other elements went into that design I am not sure of. I would like for the Corps of Engineers to explain what were the elements of their design.

Mr. OSMERS. All right.

That is my first question.

My second question is this, Mr. Chairman.

There may be, when we develop the matter here, a statement on the part of asphalt that had a similar amount of asphalt in dollars been used as dollars of rigid pavement you might have then had an equal economic test, and that under those circumstances, would have probably given you a great deal thicker asphalt pavement, you might not have had the failure that you had in the Kelly tests.

Now, is there some possibility that a difference and a thicker and heavier treatment of asphalt in the Kelly test might have held up better?

Mr. FERRY. I think I must answer that, sir.

In my judgment, it is improbable because the failure was a surface failure.

Mr. OSMERS. A surface failure.

Mr. MILLER. Mr. Chairman?

Mr. HÉBERT. Mr. Miller.

Mr. MILLER. Are you through, Mr. Osmers?

Mr. OSMERS. Yes, I am.

Mr. MILLER. Was the failure, Mr. Ferry, a disintegration? Did it come from disintegration on the part of the asphalt? Or was it a compaction?

Mr. FERRY. I think I can best answer what I saw. It was a rutting—a rut formed in the track, which resulted from a compaction of the pavement where the wheels had rolled over it.

Mr. MILLER. Now, that was, I understand, one wheel on this carriage that rode on the concrete and one on the——

Mr. FERRY. No, sir. See if I can draw a little sketch of this. I think it might help clarify for all of us what we actually did there.

We made a track like this, sir. (Drawing sketch). This is asphalt. This is concrete. We set a wagon here like this. We carried effectively one wheel there, and one wheel there. We loaded a wagon with weights. We put a tractor on the front of it. And we hauled it from one end back and forth to the other end.

Mr. MILLER. I see. I thought from your first statement——

Mr. FERRY. And the result was that we had tracks begin to show up at about 9,000 passes in the flexible pavement. Because we ran it in the same place, attempting to simulate what we have been describing as channelized traffic.

Mr. GAVIN. Why didn't you make the drawing in the first place? You would have saved us about an hour.

Mr. FERRY. You are quite right, and I apologize for it. I thought my description——

Mr. GAVIN. It is simple enough, the explanation; but if you drew the picture they would understand it.

Mr. FERRY. I thought my description last Monday would have been sufficiently graphic, but I see I am wrong.

Mr. MILLER. I want to congratulate you on your sketching ability. Mr. Ferry, the rutting that took place in the asphalt in your estimation was sufficient to reduce its efficiency to the point where it couldn't be used?

Mr. FERRY. No, sir, definitely not. The paving could still have been used. All I said is—to me, it conveyed the notion that I couldn't tell how much longer we could use it.

Mr. MILLER. Was there any deterioration in the concrete?

Mr. FERRY. There is a slight breakage here, at the points where the wheels made the transition between the two segments of the pavement.

Mr. MILLER. That would be expected.

Mr. FERRY. Otherwise, I observed no other damage. There were some minor surface cracks which could have resulted from the drying of the concrete and the setting up of it.

Mr. MILLER. What season was that?

Mr. FERRY. This was in the fall, about September or October. I saw it in Kelly the day before they shut it down.

Mr. HARDY. May I ask a question in connection with that?

Mr. MILLER. Yes.

Mr. HARDY. There was no evidence then of any subsoil failures, subgrade failures.

Mr. FERRY. None that I could observe.

Mr. HARDY. With respect to the rigid or the flexible?

Mr. FERRY. None that I could observe.

Mr. HARDY. So whatever failure you had, then, was strictly a surface failure. I wonder whether temperature played any part in it.

Mr. FERRY. The temperatures were the same in both as you would observe.

Mr. HARDY. I understand that. I understand that fully. But whether or not temperature played any part in the breakdown or the rutting in your asphalt, was the question that was in my mind.

Mr. FERRY. It is a possibility, sir.

But I am not competent enough to say that that was the cause. I would hesitate.

Mr. MILLER. Could this be ironed by resurfacing the concrete?

Mr. FERRY. We have done some ironing out of ruts. We iron it out with a hot plow and we do a pretty good job of it.

Mr. MILLER. It is not too expensive?

Mr. FERRY. Not too expensive.

Mr. GAVIN. I have a question, Colonel.

Supposing you lay out an airbase now. You have the airbase. You have the site selected. Then you determine on where your airstrips are going to be placed. What do you do about examining the substructure under which the airstrip is to be laid? That is interesting to me. Because, you are talking about the concrete, and the rigid and the flexible.

What do you have underneath that might contribute to the breakdown of either one of them, see? How extensively do you go into that?

Colonel CONNER. In both the preliminary and detailed surveys of the site the construction agent and the designer lay down a full pattern of core borings of the subsurface material, down along the center line of the proposed runway and the sides of that center line down the proposed axis of the taxiways and throughout the entire apron and all pavement areas.

Those core borings are taken down to sometimes depths of 25 feet, and the material is pulled out of the core and analyzed in the laboratories for its quality.

Mr. GAVIN. Then do you base your type of pavement on what that substructure is?

Colonel CONNER. Ultimately——

Mr. GAVIN. And the design of the pavement.

Colonel CONNER. Yes, sir, in the design of the pavement.

Mr. GAVIN. I know one place where you decided to build a base, and had all the plans and specifications laid out and then a little later on they got into their test borings and they found there was a lot of volcanic rock or something down underneath and there was no place to put a base at all.

But they didn't do that until everything was all set, the site was decided upon, the plans and specifications laid out, and they found a condition in the subsoil there where they just couldn't put the runways in there. That is why I asked the question.

Colonel CONNER. Yes.

Mr. GAVIN. Whether you are careful enough to examine that substructure before you go in there on a base and determine whether or not it is going to be ample to meet your requirements or you run into a bog or a rock or some other structure.

Colonel CONNER. I think our current practices are comprehensive enough to give us real good assurance that we have an adequate subsoil condition, or condition.

Mr. HÉBERT. Thank you very much, Colonel, and Mr. Ferry, for coming back again.

The committee will stand in recess until tomorrow morning at 10 o'clock.

Mr. FERRY. Thank you, sir.

Mr. COURTNEY. Mr. Chairman, tomorrow, the engineers.

Mr. HÉBERT. Tomorrow the engineers will be with us.

Thank you very much.

Mr. FERRY. Thank you, Mr. Chairman.

(At 11:50 a. m., the subcommittee adjourned, to reconvene at 10 a. m., of the following day, Thursday, June 27, 1957.)

AIRSTRIP PAVING MATERIALS

THURSDAY, JUNE 27, 1957

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE FOR SPECIAL INVESTIGATIONS,
Washington, D. C.

The subcommittee reconvened at 10 a. m., the Hon. F. Edward Hébert, Chairman of the subcommittee, presiding with the following members present: Mr. Hess, Mr. Gavin, Mr. Rivers, Mr. Cunningham, Mr. Fisher, Mr. Bates, Mr. Hardy, Mr. Osmers, and Mr. Miller.

Mr. HÉBERT. The committee will be in order.

Mr. COURTNEY. Mr. Chairman, I believe the Colonel has one correction to make in the record.

Mr. Chairman, in answer to the interrogatories of the subcommittee, we have asked certain questions with respect to the engineering backup information suggested in Mr. Ferry's prepared statement.

I have asked the Air Force to prepare the answers to the various questions which have been asked on that subject with relation to all of the fields, and all of the failures that have been referred to by Mr. Ferry and by the other witnesses in the course of their testimony, so that we would have in one place in the record the factual background and engineering background, or the engineering information upon which this decision has been based.

Mr. HÉBERT. All right.

Mr. COURTNEY. Colonel, will you proceed first with the correction of the record?

Colonel CONNER. Yes, sir.

Mr. Chairman, it is desired to further clarify a portion of the Air Force testimony of yesterday, June 26, concerning the adoption of the exclusive use of rigid-type pavement for primary use airfield pavements.

It was stated that the Kelly test was partially responsible for the adoption of the rigid pavement policy. It is now desired to state that this is a misstatement of fact and that the rigid pavement policy was adopted prior to the completion of the Kelly test.

The policy was adopted in December 1955. The first results of the Kelly test became known in the summer of 1956.

Mr. HESS. What do you mean by the policy was adopted now? What policy?

Colonel CONNER. The policy to go to exclusive use of rigid pavements on airfields.

Mr. HESS. That was adopted when in 1955?

Colonel CONNER. December 1955; yes, sir.

Mr. HESS. December 1955: about a year and a half after this committee had reached an agreement with the Air Force.

Colonel CONNER. Approximately so; yes, sir.

Mr. RIVERS. Could I make an observation, Mr. Chairman? If Mr. Hess is through?

Mr. HESS. Yes, go ahead.

Mr. RIVERS. You say the Kelly test had nothing to do with the adoption of the rigid pavement policy?

Colonel CONNER. That is correct, sir.

Mr. RIVERS. Has it got anything to do with the retaining of it?

Colonel CONNER. Yes, sir.

Mr. RIVERS. Or expanding it?

Colonel CONNER. Yes, sir.

Mr. RIVERS. I think that should be in the record.

Colonel CONNER. It has at this time.

But we made a flat misstatement of fact yesterday on the subject.

Mr. RIVERS. Well, there is nothing like an honest confession; it is good for the soul.

Mr. HÉBERT. Are you through?

Mr. HESS. Yes.

Mr. HÉBERT. Colonel, what was the reason of the Kelly test?

Colonel CONNER. The Kelly test was part of a continuing program that the Air Force was employing the Corps of Engineers in research and development.

Mr. HÉBERT. But the Air Force made its decision before all the results were in?

Colonel CONNER. Yes. sir.

Mr. COURTNEY. Actually, you made it before the test was undertaken?

Colonel CONNER. No, sir; the test was underway at the time.

Mr. COURTNEY. Was it?

Colonel CONNER. Yes.

Mr. HÉBERT. The test was actually—in other words, before all precincts were heard from, you declared the man elected.

Colonel CONNER. Yes, sir.

Mr. HÉBERT. We would get along very badly up here if we did that.

Mr. RIVERS. That thing is going to read mighty funny, without all the reasons in the record.

Mr. HÉBERT. It is.

Mr. RIVERS. Mr. Chairman, if you will permit me—Colonel, I would give the reason for your continuation of the Kelly tests You must have a reason for the Kelly tests.

Colonel CONNER. Yes.

Mr. RIVERS. And I think you should give them. I am not going to suggest what they are. But you ought to have a reason for them. It might be for economy, to make the concrete better and thinner and cheaper.

Mr. HÉBERT. That was the testimony yesterday, Mr. Rivers, that economy had nothing to do with the test.

Mr. RIVERS. I certainly would not get in the position where you are going to have a record to haunt you and have to change it again.

Mr. HÉBERT. I will say this, that the record is very haunting. I am afraid it is going to be like Banquo's ghost, and come up here many times, unless the Air Force determines what its policy is and does not come in here day after day to correct and clarify a record.

I recall very vividly yesterday when Mr. Leslie was testifying, he was telling me one thing and you two gentlemen were shaking your heads in the negative.

It did not make a very, very impressive record, I assure you, Colonel.

That is all. I would suggest this now, that you tell us why you conducted the Kelly test and why you made your decision before all the records were in. Supposing the Kelly test had proven contrary to what it did prove. The Air Force had already committed itself to rigid pavement, contrary to its agreement with the committee. Where would you stand then?

Colonel CONNER. We continued the Kelly test as part of a research and development program, in the hopes that it would show us that good asphalt pavement could be built. We went to our rigid policy in December 1955, based on our field experience with already existing in-use pavement.

Mr. RIVERS. Well, then, the Kelly test was really to justify asphalt more than concrete?

Colonel CONNER. It was to justify neither one, sir. It was an experimental test to see what could be done.

Mr. RIVERS. Mr. Chairman, may I ask this along with your other inquiry?

Mr. HÉBERT. Yes.

Mr. RIVERS. Was this a military expert decision or a civilian expert decision to use rigid pavement? I assume it was an expert decision.

Colonel CONNER. It was a considered decision made by the military and endorsed by the civilians.

Mr. RIVERS. Listen to that, Mr. Chairman.

Mr. HÉBERT. What was that? I am sorry.

Mr. RIVERS. In response to my question, he said this decision to utilize the rigid construction was a military expert conclusion, approved by the civilian; is that right?

Colonel CONNER. Approved.

Mr. RIVERS. Approved by the civilians.

Colonel CONNER. Endorsed by the civilian side of our house, yes.

Mr. COURTNEY. Civilian side of the Air Force?

Colonel CONNER. Yes, sir; the secretarial.

Mr. HÉBERT. Colonel, continue to make your statement.

Mr. FISHER. Mr. Chairman——

Mr. HÉBERT. Mr. Fisher?

Mr. FISHER. May I ask one question that might be pertinent at this point. In addition to the Kelly test, have there been any other tests made, say, by the Corps of Engineers in regard to the relative effectiveness of either concrete or asphalt?

Colonel CONNER. Yes, sir, there have been continuing research programs in both concrete and asphalt pavements by the Corps of Engineers at their Waterways Experiment Station, Vicksburg, Miss., and also at their Concrete Rigid Laboratory near Cincinnati, Ohio.

Mr. HÉBERT. That is all in the record, Mr. Fisher.

Mr. FISHER. Yes.

Mr. GAVIN. About $8 million has already been spent on research, is that right?

Mr. FISHER. Has the result of that been put in the record, the findings from the Corps of Engineers?

Mr. HÉBERT. No; the engineers have not testified as yet.

Mr. COURTNEY. That comes this morning.

Mr. HÉBERT. Yes.

Mr. COURTNEY. Mr. Chairman, one question.

Mr. HÉBERT. Mr. Courtney.

Mr. COURTNEY. In the course of your answer you kind of faded out in a sentence. You said the civilian side of your house and I asked you whether that meant the Department of Air Force, and you said "had approved the military decision" which was made in December of 1955 to go to rigid pavement, and you started to say something about at the secretarial level. What is the rest of that answer? Was that decision made at the Secretary's level?

Colonel CONNER. No, sir.

Mr. COURTNEY. On the civilian side of the house.

Colonel CONNER. It was approved at that level, yes, sir. It was made within Assistant Chief of Staff, Installation, United States Air Force.

Mr. COURTNEY. The decision was made within Assistant Chief of Staff, United States Air Force?

Colonel CONNER. Yes, sir.

Mr. COURTNEY. As a military decision?

Colonel CONNER. Yes, sir.

Mr. COURTNEY. Then do I understand that the civilian engineers employed in the Department of Air Force agreed with the decision?

Colonel CONNER. Yes, sir.

Mr. COURTNEY. And that the decision having been made in that manner was finally approved by the Secretary of the Air Force?

Colonel CONNER. By the Secretary of the Air Force, and finally by the Secretary of Defense.

Mr. COURTNEY. And when did those latter two decisions occur with reference to December 1955, if you know?

Colonel CONNER. The decisions were in the making all during the early fall—the fall and summer of that year.

Mr. COURTNEY. Fall and summer of 1955?

Colonel CONNER. Yes, sir.

Mr. COURTNEY. And does December 1955 represent the culmination and finalization of all decisions?

Colonel CONNER. That is when the Air Force received final approval from the Office of the Secretary of Defense.

Mr. COURTNEY. December 1955?

Colonel CONNER. Yes, sir.

Mr. COURTNEY. That is right; I just wanted to be clear on that.

Mr. HÉBERT. All right.

Have you concluded, Colonel?

Colonel CONNER. Yes, sir.

Mr. HÉBERT. Have you any additional testimony?

Mr. COURTNEY. Now—any other corrections?

Colonel ALEXANDER. Mr. Chairman, if I might——

Mr. HÉBERT. Yes, Colonel, speak.

Colonel ALEXANDER. I would like to say just 1 or 2 more things about Kelly before we get on to the next item. The Kelly test track was undertaken at the time OSD, that is the Secretary of Defense,

approved the use of portland cement concrete for channelized traffic in primary taxiways. At the time he approved that the Secretary of Defense said:

Instigate immediately further investigations on the designs to see if an adequate design for flexible pavement can be made for primary taxiways.

As a result of that, the Kelly test track as well as investigational programs at both of the Corps of Engineers Laboratories, for rigid and flexible pavement, were undertaken.

At the same time, these tests were going on, we were getting continuous reports from the field of distress in flexible pavements, not only on the primary taxiways but in other areas. As a result of these many reports of failure and distress, the decision was made in December of 1955 to go to all portland cement concrete.

Due to the directive of the Secretary of Defense and the need to gain more knowledge about the design of flexible pavement, all of the investigational programs, including Kelly, were continued, and are continuing today.

Mr. GAVIN. Under whose supervision?

Colonel ALEXANDER. The Chief of Engineers, sir.

Mr. GAVIN. Department of the Army?

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. Let me make one observation.

In connection with that, Colonel, let me say the statement you just made now is a very articulate statement. But that statement could have been made yesterday as well as today. Now, there was no secrecy about what this hearing was about. You knew about it—I mean not you as an individual; the Air Force knew about it.

Colonel ALEXANDER. Everybody knows about it.

Mr. HÉBERT. And certainly, after this controversial issue has been before us so long. Everybody representing the Air Force here should have anticipated at least in understandable knowledge that we were going to ask these questions.

The comment that I make is that it does not make a very good looking case for the Air Force to come in and change a record or to correct a record on facts which should have been common knowledge—almost routine knowledge.

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. I have been bending over backwards to give the Air Force every opportunity to put its case on the record. I will do the same with other witnesses and with the people who represent asphalt. Because the committee is not prejudiced one way or the other. We want to find out the facts.

But it becomes very difficult, I am sure, for the members of the committee to resolve this conflicting testimony and continued changing and supplementation of testimony.

Mr. RIVERS. I notice you had a number of bases cataloged on one of your statements. I don't know which one it was. The first day, I think in Mr. Ferry's statement.

Now, does this decision to use rigid construction in any wise effect the construction of the Spanish bases? You have cognizance of those, don't you?

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. Now, if my memory serves me, we have asphalt bases in Spain?

Colonel ALEXANDER. I don't believe all of them are, Mr. Rivers. I can't tell you. As I recall, the only one I was on where concrete was being formed was Torrejon.

Mr. RIVERS. Torrejon was concrete?

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. I think part of Zaragoza is asphalt.

Colonel CONNER. Yes, sir.

Mr. RIVERS. Are you agreeing with me or just——

Colonel CONNER. Zaragoza—both of those runways I believe are asphalt, with concrete ends.

Mr. RIVERS. Concrete ends. Of course, all of them are concrete ends.

Colonel CONNER. Yes.

Mr. RIVERS. Including your parking.

I know the parking is concrete, because I went there and looked at those while they were building them.

Mr. GAVIN. What year were you there, Mendel?

Mr. RIVERS. I was there the year before last.

Mr. GAVIN. I don't know. As I recall, I think they are concrete runways.

Mr. RIVERS. I thought they were concrete. I checked the question with the Navy this morning, and the Navy told me it was concrete.

Mr. HESS. Torrejon is.

Mr. RIVERS. Torrejon is concrete.

Mr. HESS. Concrete, yes.

Mr. RIVERS. Torrejon is concrete, and I think Moron may be asphalt. That is outside of Seville, if my memory serves me. I don't know what the Navy is doing down at Rota.

I don't know what that is covered with.

But I want to know this. My question is this. If you have asphalt in Spain, does this decision affect the construction? Because they are certainly SAC bases.

Colonel ALEXANDER. It would affect them, Mr. Rivers, if there is construction subsequent to the policy of December 5.

The work that was under way prior to that time would have been underway according to the criteria at that time. So it depends on when the jobs fell into the construction schedule.

Mr. RIVERS. As the chairman has called to my attention, even during construction if they found out something was better or more necessary—because there is going on in the back of the head of General LeMay's organization that perchance they might have to move out of north Africa into Spain.

Colonel ALEXANDER. Right.

Mr. RIVERS. I didn't hear General LeMay when he testified before. But I understand he gave the committee the impression that he preferred concrete. That is just my understanding.

Mr. HÉBERT. Let's continue. Is that all?

Mr. COURTNEY. Mr. Chairman, so we may complete the record, I am referring now to page 7 of Mr. Ferry's statement and to the request that we have the backup data on the various Air Force bases to which he made reference.

Overnight, the colonel has prepared answers to the same questions, with respect to each base, that were asked with reference to March Field, and Pinecastle.

So, Colonel, will you proceed in your own way and read in the questions and the answers that are given with respect to each of the bases used as data for formulating your decisions.

Colonel ALEXANDER. Yes, sir.

Mr. GAVIN. Would the gentleman repeat that again?

I didn't hear it. We don't have a statement. I want to know what you are interrogating the colonel on.

Mr. COURTNEY. The statement is Mr. Ferry's statement.

Mr. GAVIN. That is all right.

Mr. COURTNEY. Mr. Chairman, we have asked with reference to two bases a series of questions as to the nature of the fault that was found and cause of it if known, the extent of the repairs, and similar questions.

For the purpose of having a complete story, the same questions were asked with respect to all of the bases upon which this case is founded——

Mr. HÉBERT. And that will be put in the record.

Mr. COURTNEY. The colonel is now going to answer the questions with reference to the other bases not enumerated.

We have discussed March Field, and we have discussed Pinecastle.

Now, we have the other five.

Colonel, would you proceed?

Mr. HESS. Isn't he just going to extend his remarks and put them in the record?

Mr. HÉBERT. Yes.

Mr. GAVIN. Is there anything significant in what he is about to report, other than that which we have already heard?

Mr. COURTNEY. Well, you may put them in the record. It is a question of whether you want them to read them in the record——

Mr. RIVERS. It is just an implementation.

Mr. HÉBERT. Put them in the record at this point.

Mr. COURTNEY. Very well.

Mr. HÉBERT. I might say unless there is some significant change in the other five——

Colonel ALEXANDER. Mr. Chairman?

Mr. HÉBERT. Colonel Alexander.

Colonel ALEXANDER. I would like to make one other point. We have covered not only the five additional ones, but we have covered all the flexible fields on which we are having trouble. So there are several more.

Mr. HÉBERT. Have you covered all the rigid fields where you are having trouble?

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. Include them both.

Colonel ALEXANDER. Yes, sir.

Mr. GAVIN. How long will it take you to read the statement?

Colonel ALEXANDER. Oh, 15 minutes, sir, probably.

Mr. MILLER. I think he ought to read them.

Mr. HÉBERT. All right.

Colonel ALEXANDER (reading):

ALTUS AIR FORCE BASE, OKLA.

Nature of failure? Settlement of flexible pavement.
Time of failure? Spring, 1957.
Extent of failure? Unknown, being investigated by the Chief of Engineers.
Where located? Near south end of runway.
Cost of repair? Unknown.
When constructed? 1954.
Aircraft weight loads constructed for? 100,000 on twin wheels. No reconstruction has occurred. B–47 and KC–97 aircraft used this base.
Would failures have occurred regardless of surface type of pavement? Impossible to state factually, pending results of investigation by Corps of Engineers. This particular failure of flexible pavement is in addition to the structural failure of complete flexible apron and taxiways that were constructed at Altus in 1952. The flexible pavement apron and taxiways are being reconstructed currently with rigid pavement, at approximate cost of $4 million.

DAVIS-MONTHAN AIR FORCE BASE, ARIZ.

Nature of failure? Rutting of flexible pavement.
Time of failure? Occurred over a period of years from 1953 to 1955.
Extent of failure? Center of taxiway No. 14 for entire length.
Cost of repair? $198,000.
Constructed in 1952.
What aircraft weight load constructed for? 100,000 pounds on twin wheels.
Had any reconstruction occurred? No, it was new construction.
What aircraft were using base? B–47 and KC–97.
Would failures have occurred regardless of surface type pavement? No.

HUNTER AIR FORCE BASE, GA.

Nature of failure? Rutting and settlement of flexible pavement.
Time of failure? 1956–1957.
Air Rivers. Was Hunter a crash program?

LITTLE ROCK AIR FORCE BASE

Settlement of flexible pavement.
Time of failure? 1956–57.
Extent of failure? Initial distress, approximately 25 feet long, and 10 feet wide. Distress is spreading transversely and extending longitudinally along centerline of taxiway.
Where located? On primary taxiway near apron at west end.
Cost of repairs? Initial repair accomplished by a project contractor at no cost to the Government. It is estimated that it will cost $60,000 to replace the section of flexible taxiway with rigid pavement.
When constructed? 1954.
What aircraft weight load constructed for? 100,000 pounds on twin wheels.
No reconstruction had occurred.
B–47 and KC–97 aircraft were using the base.
Would failures have occurred regardless of surface-type pavement? No, if designed in accordance with current channelized design criteria for rigid pavement.

Mr. RIVERS. Did I understand him to say, Mr. Chairman, that $60,000 in repairs was absorbed by a project contractor at no cost to the Government?

Colonel ALEXANDER. No; no, sir.

Initial repairs accomplished by project contractor at no cost to the Government.

Mr. RIVERS. Project—you mean the man who built them to start with?

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. What were those failures? $60,000 is not what you are talking about now?

Colonel ALEXANDER. No, sir.

The second item—it is estimated that it will cost $60,000 to replace

Colonel ALEXANDER. I don't believe all of them are, Mr. Rivers. I can't tell you. As I recall, the only one I was on where concrete was being formed was Torrejon.

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The work that was under way prior to that time would have been underway according to the criteria at that time. So it depends on when the jobs fell into the construction schedule.

Mr. RIVERS. As the chairman has called to my attention, even during construction if they found out something was better or more necessary—because there is going on in the back of the head of General LeMay's organization that perchance they might have to move out of north Africa into Spain.

Colonel ALEXANDER. Right.

Mr. RIVERS. I didn't hear General LeMay when he testified before. But I understand he gave the committee the impression that he preferred concrete. That is just my understanding.

Mr. HÉBERT. Let's continue. Is that all?

Mr. COURTNEY. Mr. Chairman, so we may complete the record, I am referring now to page 7 of Mr. Ferry's statement and to the request that we have the backup data on the various Air Force bases to which he made reference.

Overnight, the colonel has prepared answers to the same questions, with respect to each base, that were asked with reference to March Field, and Pinecastle.

So, Colonel, will you proceed in your own way and read in the questions and the answers that are given with respect to each of the bases used as data for formulating your decisions.

Colonel ALEXANDER. Yes, sir.

Mr. GAVIN. Would the gentleman repeat that again?

I didn't hear it. We don't have a statement. I want to know what you are interrogating the colonel on.

Mr. COURTNEY. The statement is Mr. Ferry's statement.

Mr. GAVIN. That is all right.

Mr. COURTNEY. Mr. Chairman, we have asked with reference to two bases a series of questions as to the nature of the fault that was found and cause of it if known, the extent of the repairs, and similar questions.

For the purpose of having a complete story, the same questions were asked with respect to all of the bases upon which this case is founded——

Mr. HÉBERT. And that will be put in the record.

Mr. COURTNEY. The colonel is now going to answer the questions with reference to the other bases not enumerated.

We have discussed March Field, and we have discussed Pinecastle. Now, we have the other five.

Colonel, would you proceed?

Mr. HESS. Isn't he just going to extend his remarks and put them in the record?

Mr. HÉBERT. Yes.

Mr. GAVIN. Is there anything significant in what he is about to report, other than that which we have already heard?

Mr. COURTNEY. Well, you may put them in the record. It is a question of whether you want them to read them in the record——

Mr. RIVERS. It is just an implementation.

Mr. HÉBERT. Put them in the record at this point.

Mr. COURTNEY. Very well.

Mr. HÉBERT. I might say unless there is some significant change in the other five——

Colonel ALEXANDER. Mr. Chairman?

Mr. HÉBERT. Colonel Alexander.

Colonel ALEXANDER. I would like to make one other point. We have covered not only the five additional ones, but we have covered all the flexible fields on which we are having trouble. So there are several more.

Mr. HÉBERT. Have you covered all the rigid fields where you are having trouble?

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. Include them both.

Colonel ALEXANDER. Yes, sir.

Mr. GAVIN. How long will it take you to read the statement?

Colonel ALEXANDER. Oh, 15 minutes, sir, probably.

Mr. MILLER. I think he ought to read them.

Mr. HÉBERT. All right.

Colonel ALEXANDER (reading):

ALTUS AIR FORCE BASE, OKLA.

Nature of failure? Settlement of flexible pavement.
Time of failure? Spring, 1957.
Extent of failure? Unknown, being investigated by the Chief of Engineers.
Where located? Near south end of runway.
Cost of repair? Unknown.
When constructed? 1954.
Aircraft weight loads constructed for? 100,000 on twin wheels. No reconstruction has occurred. B–47 and KC–97 aircraft used this base.
Would failures have occurred regardless of surface type of pavement? Impossible to state factually, pending results of investigation by Corps of Engineers. This particular failure of flexible pavement is in addition to the structural failure of complete flexible apron and taxiways that were constructed at Altus in 1952. The flexible pavement apron and taxiways are being reconstructed currently with rigid pavement, at approximate cost of $4 million.

DAVIS-MONTHAN AIR FORCE BASE, ARIZ.

Nature of failure? Rutting of flexible pavement.
Time of failure? Occurred over a period of years from 1953 to 1955.
Extent of failure? Center of taxiway No. 14 for entire length.
Cost of repair? $198,000.
Constructed in 1952.
What aircraft weight load constructed for? 100,000 pounds on twin wheels.
Had any reconstruction occurred? No, it was new construction.
What aircraft were using base? B–47 and KC–97.
Would failures have occurred regardless of surface type pavement? No.

HUNTER AIR FORCE BASE, GA.

Nature of failure? Rutting and settlement of flexible pavement.
Time of failure? 1956–1957.

Mr. RIVERS. Was Hunter a crash program?

Mr. COURTNEY. Originally, you mean?

Colonel ALEXANDER. I don't think so, but I can answer definitely, Mr. Rivers.

Mr. RIVERS. I was speaking about putting B–47's at Hunter. Was that program a crash program?

Colonel ALEXANDER. No, sir. [Reading:]

Extent of failure? Unknown, being investigated by the Corps of Engineers.
Where located? Along centerline of primary taxiway.
Cost of repairs? Unknown at this time.
When constructed? 1953.
What aircraft weight load constructed for? 100,000 pounds on twin wheels. Which was the design loading for the B–47.
Had any reconstruction occurred? No.
What aircraft were using base? B–47 and KC–97.
Would failures have occurred regardless of surface type pavement? This can't be determined pending completion of investigation.

HOMESTEAD AIR FORCE BASE, FLA.

Nature of failure? Settlement of flexible pavement.
Type of failure? Has been developing during past few months.
Extent of failure? Unknown. Being investigated by Corps of Engineers.
Where located? On center line of primary taxiways.
Cost of repairs? Unknown at this time.
When constructed? 1954.
What aircraft weight load constructed for? 100,000 pounds on twin wheels.
Had any reconstruction occurred? No.
What aircraft were using base? B–47 and KC–97.
Would failures have occurred regardless of surface-type pavement? Can't say until investigation has been completed.

LITTLE ROCK AIR FORCE BASE

Settlement of flexible pavement.
Time of failure? 1956–57.
Extent of failure? Initial distress, approximately 25 feet long, and 10 feet wide. Distress is spreading transversely and extending longitudinally along centerline of taxiway.
Where located? On primary taxiway near apron at west end.
Cost of repairs? Initial repair accomplished by a project contractor at no cost to the Government. It is estimated that it will cost $60,000 to replace the section of flexible taxiway with rigid pavement.
When constructed? 1954.
What aircraft weight load constructed for? 100,000 pounds on twin wheels.
No reconstruction had occurred.
B–47 and KC–97 aircraft were using the base.
Would failures have occurred regardless of surface-type pavement? No, if designed in accordance with current channelized design criteria for rigid pavement.

Mr. RIVERS. Did I understand him to say, Mr. Chairman, that $60,000 in repairs was absorbed by a project contractor at no cost to the Government?

Colonel ALEXANDER. No; no, sir.

Initial repairs accomplished by project contractor at no cost to the Government.

Mr. RIVERS. Project—you mean the man who built them to start with?

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. What were those failures? $60,000 is not what you are talking about now?

Colonel ALEXANDER. No, sir.

The second item—it is estimated that it will cost $60,000 to replace the section of flexible taxiway with rigid pavement.

Mr. RIVERS. You don't know what caused the first failure?

Colonel ALEXANDER. No, sir.

Mr. RIVERS. It might have been just a sorry contractor.

Colonel ALEXANDER. Mr. Leslie tells me it was channelized traffic.

Mr. RIVERS. Channelized traffic.

I wish you would put in layman's words what "channelized traffic" means. It means one wheel running behind the other on a certain part of the runway, doesn't it?

Colonel ALEXANDER. Continuously; yes sir. It is just like it was on streetcar tracks, Mr. Rivers. It goes down that same track time after time after time.

Mr. RIVERS. What do you have—a white line down there where they can't miss it?

Colonel ALEXANDER. We have a white centerline, and he stays as close to it as possible.

Mr. RIVERS. Stays as close to the centerline?

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. I see.

The area is the channel. You got me less confused with that than you did with the original one.

Mr. HÉBERT. Continue.

Colonel ALEXANDER. March Air Force Base is already in the record.

Pine Castle Air Force Base——

Mr. COURTNEY. Is in the record.

Colonel ALEXANDER (reading):

FAIRCHILD AIR FORCE BASE, WASH.

Nature of failure? Rutting of flexible pavement in certain channelized traffic lane. Time of failure? During past 3 years. Extent of failure? Full length of primary taxiway. Approximately 22 feet each side of taxiway centerline—that was where located.

Cost of repairs? Unknown. When constructed? 1953.

What aircraft weight load constructed for? 100,000 pounds on twin wheels. No reconstruction has occurred. B–36 aircraft were using base.

Would failures have occcurred regardless of surface type pavement? Can't say until investigations are completed by Corps of Engineers.

WALKER AIR FORCE BASE, N. MEX.

Rutting of flexible pavement.

Time of failure? During past 2 years.

Extent of failure? Unknown pending completion of investigation.

Located? On primary taxiway, approximately 22 feet each side of taxiway centerline.

Cost of repair? One project cost $30,000, and another project now being advertised is estimated to cost $130,000.

When constructed? 1952–53.

What aircraft weight load constructed for? 100,000 pounds on twin wheels.

Had any reconstruction occurred? Yes. If so, what was it? The initial project called for strengthening on existing flexible pavement runway for use as taxiway.

What aircraft were using base? B–36.

Would failures have occurred regardless of surface type pavement? Can't say until investigations are completed by Corps of Engineers.

I have two on Castle Air Force Base.

The first one: Settlement and cracking of flexible pavement.

Time of failure? During past 12 months.

Extent of failure? Unknown pending investigation by Corps of Engineers.

Where located? On runway near south end, and is a channelized area.

Cost of repair? Unknown pending investigation by Corps of Engineers.

When constructed? 1954.

What aircraft weight load constructed for? No load design was specified. Project called for constructing 4-inch bituminous overlay on existing flexible pavement runway.

Had any reconstruction occurred? No.

What aircraft were using base? B–47 and B–52.

Would failures have occurred regardless of surface type pavement? Can't say pending investigation by Corps of Engineers.

The second one at Castle.

Nature of failure. Built in grade differential.

Time of failure? 1953.

Extent of failure? Series of pavement sections which were constructed as much as three-tenths of a foot below plan grade.

Where located? On runway—it is located on primary runway.

Cost of repair? $30,000 for one project. Another project estimated to cost $130,000 is being prepared for contract.

When constructed? 1953.

The last questions are the same as the first item for Castle.

Mr. RIVERS. Mr. Chairman, right there. Castle is out in California.

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. While you are doing the repairing, you are making it now accessible to the 52 specifications? You are repairing and building it thicker at the same time, aren't you?

Colonel ALEXANDER. Mr. Rivers, when we repair a small area or comparatively small area on one of these large runways, our normal practice is to fill in the holes to the same strength that the rest of the pavement is.

If the areas grow larger, then we have to come in with a project for strengthening the entire thing. But we never felt it was practical to fill a small hole stronger than what is around it.

Mr. RIVERS. I was thinking that base was built for 47's, really; I mean in strength.

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. You have 52's there, haven't you?

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. So you are probably preparing a project now, aren't you?

Colonel ALEXANDER. No, sir.

On this entire item of strengthening for the B–52's, the way we are thinking is—until they start showing some serious signs of distress, we won't come in for strengthening projects.

Mr. RIVERS. And there are no signs of that now?

Colonel ALEXANDER. There are signs of the roughness—we are just not sure what the extent of this first is.

Mr. RIVERS. There are signs of certain elements of deterioration?

Colonel ALEXANDER. Yes, sir, and we are not sure of the extent. This is the third one at Castle. [Reading:]

Nature of failure? Cracking of rigid pavement in channelized traffic area.
Time of failure? During past 18 months.
Extent of failure? Unknown pending investigation by Corps of Engineers.
Located? On primary taxiway, on through taxiway leading from pavement parking apron.
Cost of repair? Unknown pending investigation by Corps of Engineers.
When constructed? 1952.
What aircraft weight load constructed for? Project specified the design load would be the same as existing connecting pavements.
What aircraft were using base? B–47 and B–52.
Would failures have occurred regardless of surface type pavement? Yes, because pavement is overloaded.

TINKER AIR FORCE BASE, OKLA.

Nature of failure? Settlement and rutting of flexible pavement.
Extent of failure? Approximately 160,000 square yards.
Where located? Entire portion of runway, which was strengthened.
Cost of repair? Estimated $2 million to reconstruct.
When constructed? 1954.
What aircraft weight load constructed for? 100,000 pounds on twin wheels.
Had any reconstruction occurred? Yes. If so, what was it? Flexible pavement overlay.
What aircraft were using base? All types, as this is an AMC depot. That includes the B–47 and the KC–97.
Would failures have occurred regardless of surface-type pavement? No.

WESTOVER AIR FORCE BASE, MASS.

Nature of failure? Nonuniform settlement of flexible pavement.
Time of failure? During past 12 months.
Extent of failure? Unknown, pending investigation by Corps of Engineers.
Where located? On runway. Various preliminary reports do not specify exact locations.
Cost of repair? Unknown, pending results of investigation by Corps of Engineers.
When constructed? 1955.
What aircraft weight load constructed for? 100,000 pounds on twin wheels.
No reconstruction had occurred. B–47 and B–52 aircraft were using base.
Would failures have occurred regardless of surface-type pavement? Unknown, pending results of investigation by Corps of Engineers.

Mr. MILLER. Is that a permanent, or is that an asphalt or a concrete pavement?

Colonel ALEXANDER. That was flexible pavement, sir.

Mr. MILLER. Excuse me.

Colonel ALEXANDER. Lake Charles Air Force Base, La.

Nature of failure? Cracks in rigid pavement in channelized traffic areas.
Extent of failure? Minor.
Where located? On primary taxiway and runway at south end.
Cost of repairs? None to date.
When constructed? 1952.
What aircraft weight load constructed for? 100,000 pounds on twin wheels.
No reconstruction had occurred. B–47 aircraft were using base.
Would failures have occurred regardless of surface-type pavement? Yes.

FORBES AIR FORCE BASE, KANS.

Nature of failure? Cracking of rigid pavement in channelized traffic areas.
Time of failure? During past 12 months.
Extent of failure? Unknown, pending results of investigation by Corps of Engineers.
Located? On primary taxiway in channelized traffic area.
Cost of repair? Unknown, pending results of investigation by Corps of Engineers.
Constructed? 1954.
What aircraft weight load constructed for? 100,000 pounds on twin wheels.
No reconstruction had occurred. B–47 aircraft are using base.
Would failure have occurred regardless of surface-type pavement? Unknown, pending results of investigation by Corps of Engineers.

Mr. RIVERS. If the rest of them are like that, Mr. Chairman, why can't we just put them in?

Mr. HÉBERT. Members of the committee want to hear them, Mr. Rivers.

Mr. GAVIN. Call the names of them off and put the rest of it in the record.

Mr. RIVERS. Yes.

Colonel ALEXANDER. All right. [Reading:]

SMOKY HILL AIR FORCE BASE

Nature of failure? Spalling of joints in rigid overlay pavement.
Time of failure? 1956.
Extent of failure? Scattered locations.
Where located on runway? Generally.
Cost of repair? Unknown.
When constructed? 1955.
What aircraft weight load constructed for? 100,000 pounds on twin wheels.
Had any reconstruction occurred? No.
What aircraft were using base? B–47.
Would failures have occurred regardless of surface type pavement? No. This type of failure is peculiar to rigid pavement only and due to poor construction practice.

LUKE AIR FORCE BASE, ARIZONA.

Nature of failure? Bleeding due to excess asphalt in bituminous mix and poor plant control.
Time of failure? 1953.
Extent of failure? Generally.
Where located? Generally, but more pronounced on taxiways.
Cost of repair? No repairs have been accomplished outside of occasional applications of sand to absorb the excess asphalt.
When constructed? 1952.
What aircraft weight load constructed for? 25,000 pounds on single wheel.
Had any reconstruction occurred? No.

What aircraft were using base? F-84.
Would failures have occurred regardless of surface type pavement? No. This type of failure is peculiar to asphaltic concrete pavement only.

Colonel ALEXANDER. Vincent Air Force Base.

Mr. HÉBERT. V-i-n-s-o-n?

Colonel ALEXANDER. V-i-n-c-e-n-t. [Reading:]

Nature of failure? Bleeding due to excess asphalt in bituminous mix.
Time of failure? 1954.
Where located? On primary taxiway and runway.
Cost of repair? No repairs have been accomplished outside of occasional applications of sand to absorb excess asphalt.
When constructed? 1954.
What aircraft weight load constructed for? 25,000 pounds on single wheel.
Had any reconstruction occurred? No.
Would failures have occurred regardless of surface type pavement? No. This type of failure is peculiar to asphaltic concrete only.

Smoky Hill Air Force Base, Kans. Luke Air Force Base, Ariz. Vincent Air Force Base, Ariz.

Myrtle Beach Air Force Base, S. C.

Mr. RIVERS. They just finished that one.

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. Read that. I want to hear about that.

Colonel ALEXANDER. [Reading:]

Nature of failure? Distortion and cracking of flexible type pavement.
Time of failure? 1956.
Extent of failure? Unknown, pending results of investigation by Corps of Engineers.
Located on taxiway.
Cost of repair? Unknown pending results of investigation.
Constructed? In 1955.
What aircraft weight load constructed for? 25,000 pounds on single wheel.
Had any reconstruction occurred? No.
Would failures have occurred regardless of surface type pavement? Unknown, pending results of investigation by Corps of Engineers.

Mr. RIVERS. That is very interesting, Mr. Chairman, because they haven't even the planes there yet. You got about half a dozen or maybe a little more. But you haven't even gotten your wings implemented.

Colonel ALEXANDER. There must be some traffic there, Mr. Rivers.

Mr. RIVERS. A little. You don't have many planes there. You are just now phasing them in.

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. It looks to me like that burst right in your face.

Colonel ALEXANDER. Just about.

Mr. GAVIN. Weather conditions down there.

Mr. RIVERS. It just goes to show you that is what you get for letting some of these yankees go down there to build runways?

Mr. HÉBERT. Continue, Colonel.

Colonel ALEXANDER. That concludes the fields I have.

Mr. HÉBERT. Now, Colonel, there is just one question that I wanted to ask you in connection with the list you read. As I followed you along, I noticed that most of these failures have occurred within the last 18 months or 2 years, is that correct?

Mr. GAVIN. 1952 and 1953.

Mr. HÉBERT. No, no; they were constructed. I am talking about the failures.

Colonel ALEXANDER. A good portion of them have, but they have also been occurring over—oh, since 1953. Since the B–47 came into the picture we have had distress accelerating. We got the first signs of it when the first B–47's came in.

Really, the thing that changed us to this portland cement criteria in December 1955 was the growing number of reports that we were getting from the field on distress.

We realized at that time that many of them were small, but it was an indication of things to come. The Air Force felt we couldn't take the chance.

Mr. HÉBERT. How about the B–52? Did that have anything to do with it?

Colonel ALEXANDER. No, sir. The B–52 first reflected in our pavement criteria when we changed from 100,000 pounds on twin wheels to 240,000 pounds on the twin-twin wheels.

Mr. HESS. When was that?

Colonel ALEXANDER. That was in May of 1956.

Mr. RIVERS. That was at Castle, mostly.

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. And then it began to reflect on the rigid pavements.

Colonel ALEXANDER. Yes, sir. The B–47 reflected in the rigid pavement also, Mr. Hébert, at Lake Charles.

Mr. HÉBERT. And then it was accelerated when the B–52's came in?

Colonel ALEXANDER. Not significantly, as we don't have enough of them operating.

Mr. HÉBERT. You don't know.

Colonel ALEXANDER. Also they are operating at light loads, as most of them are still in a training status.

Mr. HÉBERT. All right. Is that all, Colonel?

Colonel ALEXANDER. Yes, sir.

Mr. RIVERS. May I ask General Wilson a question before I go?

Mr. HÉBERT. We will get around to him. Let us finish.

Mr. Courtney.

Mr. COURTNEY. Colonel, the information which you have just given the committee with reference to the list of bases to which you have made reference is the sum of the information which the Air Force has upon which it has based its engineering judgment concerning the present criteria?

Coloned ALEXANDER. Yes. I would like to amend that slightly.

The only thing we have reported to you in this list, are what we term structural failures. We have not considered any heat, blast, fuel spillage—we have many of those, and we have not brought those up. All these are structural failures, we consider.

Mr. COURTNEY. That is right.

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. The other types of failures have been enumerated in Mr. Ferry's statement, but they deal with surface conditions.

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. Rather than structural failures.

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. Colonel, in many of the bases to which you made reference in this list, you made reference to the fact that the bases were constructed in 1954—I think 5 of them as I counted them on

my fingers—and that they were designed for 100,000-pound loading, which is the present design criteria.

Colonel ALEXANDRIA. No, sir. Our present criteria is 240,000.

Mr. COURTNEY. 240,000.

Colonel ALEXANDER. Yes, sir.

Mr. COURTNEY. I beg your pardon.

All right. Pass the question. That is all with the colonel at the moment.

Mr. HÉBERT. Thank you very much, gentlemen.

Mr. HARDY. Mr. Chairman, could I ask a question about yesterday's testimony, while we have the colonel on the stand?

Mr. HÉBERT. Yes.

Mr. HARDY. Yesterday, we have some discussions about the test track at Kelly. I am not entirely clear—there is some confusion, at least in the testimony as I read it, with respect to the extent of the damage and what would have been involved in repairing the damage.

Now, I understood from the testimony that the damage on the test track was purely surface damage, is that correct?

Colonel ALEXANDER. Mr. Hardy, we have not received in Air Force Headquarters the formal report of the Kelly test track from the Corps of Engineers that performed it.

I would like to pass that question to the Corps of Engineers witnesses to describe that to you.

Mr. HARDY. Let me ask a question, Colonel.

Colonel ALEXANDER. Yes, sir.

Mr. HARDY. Was the damage on that Kelly test track repaired?

Colonel ALEXANDER. No, sir.

Mr. HARDY. It has not been repaired?

Colonel ALEXANDER. The Kelly test track was built into an operational Air Force base. It was built on a taxiway that was an integral part of this base. The original intent was that this one-time test would be run, and the base would be allowed to get back on the taxiway and operate.

Mr. HARDY. Was the surface of that area where the asphalt concrete was laid—was that surface repaired?

Colonel ALEXANDER. No, sir.

Mr. HARDY. It is not in use today?

Colonel ALEXANDER. Pardon me, sir. I made a misstatement. The taxiway has been reconstructed, and it is now part of the operational base at Kelly.

Mr. HARDY. Do you know the extent to which that taxiway was reconstructed and what was done in its reconstruction?

Colonel ALEXANDER. No, sir.

Mr. HARDY. Do you know whether, in fact, there was anything more than a resurfacing?

Colonel ALEXANDER. No, sir.

Mr. HARDY. Then you don't know whether there was a repair—whether that surface was actually repaired or whether it was rebuilt?

Colonel ALEXANDER. No, sir.

Mr. HARDY. Then you don't have any information as to what cost was involved in putting that section of the taxiway back into service?

Colonel ALEXANDER. No, sir.

Mr. HARDY. Then to say that the cost figures are not available would not necessarily be a factual statement, because somebody must know.

Colonel ALEXANDER. I am sure they do, sir.

Mr. HARDY. And to say that that section has not been repaired would not necessarily be factual, either, if you don't know whether it was reconstructed or merely resurfaced, would it?

Colonel ALEXANDER. Well, I feel—I don't personally know that the thing has been repaired, but I feel confident it has, because the field is operational.

Mr. HARDY. If it is in use, it would have had to be repaired, wouldn't it?

Colonel ALEXANDER. That is correct.

Mr. HARDY. Mr. Chairman, the reason I raised these questions is that I had understood that that section was in service and that aircraft are using it every day, and the testimony that we had in here yesterday left me under the distinct impression that it had not been repaired and that it was sitting there and is idle and nobody could tell what the cost would be to repair it.

Now, actually, Mr. Leslie's testimony on it is pretty misleading, in my judgment.

There was a considerable floundering around as to what it would cost to repair it. In fact, there was a question raised as to whether or not it was repairable, and there was a little dispute about that, until finally Mr. Ferry said, of course, it was repairable. And now we find, or we have testimony, that it is actually in daily use.

So, frankly, I think that we have been—the committee has been done a disservice in the kind of testimony we had about that stuff yesterday. I want to pursue it further when we get to the engineers. But I thought, while we had these people here, we ought to at least establish the fact that it is in use as of today. Is that correct?

Colonel ALEXANDER. As far as I know, yes, sir.

Mr. HÉBERT. Thank you very much, gentlemen.

Mr. GAVIN. Maybe Mr. Leslie would want to make a comment. Your name was referred to. Do you have a comment to make?

Mr. LESLIE. I have nothing further to state, Mr. Gavin.

Mr. HARDY. Mr. Chairman, as long as that has been raised, maybe Mr. Leslie ought to look at what he said yesterday, because he indicated there was some question as to whether or not it could be repaired. I have the transcript right before me. Mr. Bates raised the question:

> Well, could you have repaired it so that it would be usable?

and Mr. Leslie said,

> We could have made a temporary repair. I wouldn't say that it would have stood up under continuous traffic for another 5, 10, or 15 years.

The plain implication, Mr. Chairman, is that no repair was made. There is another section in here. Mr. Hébert says:

> Your answer to Mr. Bates is you don't know, Mr. Leslie—

and Mr. Leslie said:

> In the case of the Kelly test track, I believe that, over a period of time, the amount of effort spent on making temporary repairs would soon eat up the original cost of the pavement.

Quite obviously, he didn't have any idea that it had been done. And I don't think it is particularly good testimony for witnesses, with the competence that these people have, to come in here and leave us with that kind of testimony.

Mr. HÉBERT. Any comment, Mr. Leslie?

Mr. LESLIE. There is no intention on the part of any one of us, I believe, Mr. Hardy, and Mr. Hébert, to leave the idea that no repairs had been made or repairs could not have been made. I haven't been down there, and I don't know what the exact condition of the pavement is to date. It is very possible—and that is what I was referring to yesterday when I made the statement; that it is possible to make temporary repairs. I say it is very possible that the engineer at Kelly may have gone out there, and put a temporary repair on it, just like we do at any of the other bases where we have failures of that kind.

Mr. HARDY. Let me ask you another question. When were you down there, Mr. Leslie?

Mr. LESLIE. In July 1956, Mr. Hardy.

Mr. HARDY. It has been a long time ago.

Mr. LESLIE. Yes, sir.

Mr. HARDY. Now, I am going to read a little bit more of your testimony, as long as we got into this. Mr. Bates asked you how much damage was done to the asphalt in the Kelly test.

Mr. LESLIE. I don't have—we don't have the final report on the Kelly test track, Mr. Bates.

Mr. Leslie continues:

When I was down there, there was what could be described briefly as a shoving of the asphaltic concrete to the side. There was about an inch, an inch and a half depression.

That was over a year ago.

Mr. LESLIE. Yes, sir.

Mr. HARDY. Certainly, the assumption was left with me that there hadn't been any repair made as of now.

Now, to continue on, Mr. Chairman, with Mr. Leslie's testimony, Mr. Bates said:

Well, could you have repaired the asphalt of this field?

Mr. LESLIE. We could have made a stab at replacing the surface on the binder course.

Now, of all the crazy, gobbledygook testimony, Mr. Chairman. I think it is an insult to this committee that we have that kind of testimony in our record.

Mr. LESLIE. Mr. Hardy, it is very possible, as I said before, that the base engineer could have made a repair job.

Mr. HARDY. Mr. Leslie, you come in here to testify before this committee on conditions. We talk about conditions, whether or not repairs have been made, and you testify with respect to a condition which existed a year ago, and you must have known. Now, somebody in your office must have known that that section was in daily use.

Mr. LESLIE. Not necessarily—it is not necessarily the fact that we are up to date on the daily activities going on down at base level, Mr. Hardy.

Mr. HARDY. Mr. Chairman, I just wanted to clear up what to me seemed to be a misrepresentation yesterday.

Mr. FISHER. Mr. Chairman?

Mr. HÉBERT. Mr. Fisher?

Mr. FISHER. Mr. Chairman, can't we save a lot of time and a lot of recordmaking by waiting for the witness who has been down there and can give us the actual facts?

Mr. HÉBERT. That is right. I am trying my best, Mr. Fisher, to try to get to it.

Mr. FISHER. We are spending 30 minutes on something these people were never down there to see, and somebody has seen it, and we can get to them.

Mr. HÉBERT. We are trying to get to the engineers. Just one final question I want to ask. Is the Kelly test the only test that was made as a comparable test between the rigid and the flexible pavement? I mean pitted one against the other.

Colonel ALEXANDER. At one location.

Mr. HÉBERT. Yes. That is all I want to know. Thank you very much.

Mr. GAVIN. I just want to say this. I don't quite agree with my very able colleague over there. I didn't know too much about rigid or flexible pavement when I came in here to listen to this testimony, and I think the Department of the Air Force has given us a comprehensive picture of the problem, and what they are trying to do, to see if they can't improve the whole situation and to bring flexible pavement into the picture.

Now, I think it is quite difficult for a man like Mr. Leslie to cover every yard of every airstrip that is under question, to check and recheck and doublecheck. I suppose he would be on the go all the time if he had to go down and look over every piece of airstrip that was in question.

I presume, as far as I am concerned, the gentleman, to the best of his ability and knowledge, presented to the committee the facts as he saw them. I don't think that he was trying, at least in my estimation, to mislead the committee in any way in reaching a determination of this question.

Mr. BATES. Mr. Chairman?

Mr. HÉBERT. Mr. Bates.

Mr. BATES. Mr. Chairman, on yesterday I asked for comparable cost figures, not only the initial cost but the maintenance cost over a protracted period of time, to try to determine just what the cost factors are. Have they been supplied for the record?

Mr. COURTNEY. Not as yet, Mr. Bates.

Mr. BATES. They will be?

Mr. HÉBERT. They will be.

Colonel CONNER. We are working on that now, sir.

Mr. HÉBERT. All right, thank you very much, gentlemen, for the allowance of your time.

Mr. COURTNEY. General Wilson—General Wilson and party, if you wish.

TESTIMONY OF MAJ. GEN. WALTER K. WILSON, JR., DEPUTY CHIEF OF ENGINEERS FOR CONSTRUCTION; H. B. ZACHRISON, CHIEF OF THE ENGINEERING DIVISION, MILITARY CONSTRUCTION BRANCH, AND JAMES P. SALE, CHIEF OF THE SOILS SECTION, AIRFIELDS BRANCH, ENGINEERING DIVISION

Mr. COURTNEY. Mr. Sale, you are appearing in lieu and instead of Mr. T. B. Pringle, who is incapacitated at the moment.

Mr. SALE. Yes, sir.

Mr. COURTNEY. General, I think you have a prepared statement. Will you proceed with it, please?

General WILSON. I do.

Mr. HÉBERT. Proceed, General.

Mr. GAVIN. Glad to see that the Department of the Army is here now. We ought to be able to get this whole problem solved.

Mr. HÉBERT. Proceed, General.

General WILSON. Mr. Chairman, with your concurrence I propose to present the Corps of Engineers picture in three general phases. The first phase will be my opening statement, of which you have a copy. The second phase would be to attempt to answer general questions, during which time, if the questions get into a detailed point, I would expect to call on other technicians I have available to give factual answers at that time. The third phase is to be the presentation of the investigational program which has been under discussion, at which time the rigid pavement would be discussed by Mr. Hutchinson from our Ohio River Division Laboratory, the flexible pavement would be next, and discussed by Mr. Foster of the Waterways Experiment Station, and the third phase would be the heat and blast effects, discussed by Mr. Duvall of our Ohio Division River Laboratory.

If that meets with your concurrence, that is the basic——

Mr. HÉBERT. It certainly meets with my concurrence, and approbation, General.

Proceed.

General WILSON. We also have Dr. Turnbull here, whom you requested as a witness, from the Waterways Experiment Station.

Mr. COURTNEY. Vicksburg, Miss.

General WILSON. Vicksburg, where the flexible laboratory is located.

Mr. HÉBERT. All right, General, proceed.

General WILSON. The Chief of Engineers as construction agent for the Department of the Air Force has endeavored to provide the most economical airfield pavements meeting operational requirements. Since February 1952, about 71 million square yards of new pavements have been built of which 63 percent have been of the rigid type, and 37 percent of the flexible type. Of a total cost of $400 million, about 77 percent were for rigid and 23 percent for flexible. These costs include only the cost of the paving down to the subgrade and not such items as clearing, grading, and drainage.

In early 1955, it became evident that changing operational requirements, heavier aircraft weights, higher tire pressures, ground traffic "channelization" due to steerable bicycle landing gear, and porpoising

necessitated development of more critically designed pavement structures with attendant higher costs.

The need for better pavement ingredients has in some instances necessitated transportation of stone and aggregates from remote locations with lessened use of local job-site materials which were adequate for the designs of prior years.

Similarly, all related phases of pavement design and construction have required intensive development and refinement, including research and testing programs to formulate new criteria, more detailed soil investigations prior to design, top level review of field prepared designs, amplification of specifications, additional inspection procedures, and evaluation of completed structures.

The Chief of Engineers has continuously followed the principles of permitting use of economically available materials and methods meeting sound engineering design requirements and known operational and functional needs of the using service for a specific project.

For airfield pavements, built prior to 1954, the competitive materials for Air Force, Army, and Air National Guard construction were asphaltic concrete and portland cement concrete, designated flexible and rigid pavements, respectively.

I shall discuss flexible pavements first.

FLEXIBLE PAVEMENTS

Since 1952, approximately 26 million square yards of new flexible pavements have been designed and constructed by the Corps of Engineers at some 105 Air Force bases throughout the United States and overseas. Pavement distress has been reported as of this date, which is about a week ago, to the Chief of Engineers at 16 of these installations; 13 on heavy-load (11 B–47 and 2 B–52) pavements and 3 on light-load pavements.

In 10 of the 13 heavy-load pavements which showed distress, the problem was confined to areas subjected to the channelized traffic of B–47 aircraft. At one of these, distress was reported in both channelized and nonchannelized areas. Channelization, which is the concentration of all traffic into a very narrow pavement lane, results when certain aircraft, equipped with steerable landing gear, follow taxiway and runway paint stripes with little lateral distribution.

Channelization may be termed an overload caused by a greater number of repetitions of traffic than the designs were based on.

This represents a condition of "overuse" by producing approximately six times the number of load repetitions assumed in design prior to 1955. Pavement areas subjected to channelization traffic actually represent less than 10 percent of the total pavements at a given airfield.

Investigation and evaluation have been made on 12 (10 heavy-duty and 2 light-duty) of the 16 cases of pavement distress reported.

Of the remaining cases, 2 are currently being investigated, and 2, which were reported within the past week, will be investigated as soon as possible. Channelization of traffic was a major factor in 8 cases of the 12 investigated.

Deficient design and construction was primarily the cause of distress in the other 4 cases investigated; 2 of these were heavy-duty,

not channelized, and 2 were light-duty. The Chief of Engineers believes there would have been substantially fewer reported deficiencies had channelization not occurred because of an operational characteristic of the B–47 aircraft.

In June 1955, new design criteria were prepared which provided for the channelized traffic of the B–47. In March 1956, similar criteria for the channelized traffic and increased loadings of the B–52 aircraft were issued. The behavior of flexible pavements in the accelerated traffic tests initiated in 1955 at the Waterways Experiment Station and at Kelly Air Force Base, Tex., indicated that the revised design criteria for the B–47 and B–52 loadings are adequate for the layers underlying the asphaltic concrete pavement—that is, the subgrade, subbase, and the base course—but this needs verification. These same test sections showed the asphaltic concrete layer of the flexible pavements to be inadequate.

The latest revisions to design criteria (July 1956) for the asphaltic concrete layers, currently being traffic-tested at the Waterways Experiment Station, should result in pavements that are safe for the B–47 loading, and may well be safe for the B–52 loading from the standpoint of displacement under traffic.

It should be emphasized, however, that further research and experience are required to prove up this load-carrying capability and to establish whether or not the desired pavement life can be attained due to a potential reduction in durability associated with these new surface layer criteria.

With regard to future aircraft loadings heavier than the present B–52, sufficient work has been done on the design of flexible pavements to indicate that the remaining problems associated principally with the asphaltic layer may not be insurmountable.

Further investigation is definitely required before any design or construction for these extremely heavy loadings is initiated.

There are cogent reasons why a heavy-load flexible design should be available for use in case of need. These reasons include:

(*a*) It is impractical to build extensive portland cement concrete pavements in arctic regions such as Thule Air Force Base, Greenland, due to short periods of appropriate temperature.

(*b*) In areas where sound concrete aggregate is unavailable, such as Bermuda, the cost of portland cement concrete is prohibitive.

(*c*) Flexible type pavement lends itself more readily to rapid construction by troops in time of war.

RIGID PAVEMENTS

During the past 5 years, approximately 45 million square yards of new heavy- and light-load rigid pavements have been designed and constructed by the Corps of Engineers at 136 Air Force bases. Rigid pavements have evidenced fewer cases of pavement distress than flexible pavements even though subjected to the same channelized traffic. The Chief of Engineers is aware of three airfields showing distress as a result of channelized traffic, and two instances of distress not directly associated with overload.

Rigid pavements designed and constructed prior to 1955 for the B–47 loading have shown a minor amount of cracking under the

channelized traffic of that aircraft. A more rapid progression of defects on these pavements may be anticipated under the overload of the B–52 aircraft.

Revisions to design criteria made in 1956 which took channelization and the heavier loading of the B–52 into account will produce rigid pavements that are capable of carrying the B–47 and B–52 aircraft.

An adequate traffic-testing program is currently underway to develop valid design criteria for the future aircraft loadings.

In addition, traffic tests are being made utilizing reinforced concrete, prestressed concrete, and cement-treated base courses for both new pavements, and for strengthening existing pavements.

Pavement engineers consider that these materials may eventually relieve some of the design and construction problems associated with very thick concrete pavements, and strengthening existing pavements.

SUMMATION

In summation, for the B–52 aircraft, we have a proven design criteria for rigid pavements but not for flexible pavements.

In order to meet the anticipated future construction requirements of the Air Force, a continuation of the following investigational projects is essential: (1) The development of valid flexible pavement design criteria for the B–52 loading; (2) The development of valid rigid and flexible pavement design criteria for future loadings heavier than the B–52; (3) determination of the most economical methods for strengthening existing pavements with rigid overlays.

Now, following that statement, Mr. Chairman, is a tabulation of the numbers that I have used in the opening statement, to explain in case there are questions.

Following that, on the next page, is a very much summarized and brief statement of those pavements which are covered—where they are, what traffic has used them to date, whether or not the distress has developed in the channelized or nonchannelized area, and a very brief statement of why and how it developed. That consists of two pages. One is on flexible heavy duty. The next page consists of rigid heavy duty. And then a further page on flexible pavement light duty.

I would like to emphasize that none of the bases listed on these two tables or discussed in my presentation were designed for channelized traffic or for the B–52 loading.

Now, there is one last page which attempts to further clarify the brief remarks in the right hand column on those pages.

(The attachments referred to are as follows:)

TABULATION OF NUMBERS OF AIRFIELDS USED IN OPENING STATEMENT

FLEXIBLE PAVEMENTS

Sixteen cases reported to OCE: 13 heavy duty, 3 light duty.

Twelve cases of the 16 have been investigated: 10 heavy duty, 2 light duty.

Two cases of the 16 are currently being investigated: 1 heavy duty, 1 light duty.

Two cases of the 16 (recently reported) will be investigated: 2 heavy duty.

Heavy duty

Altus, Okla.: channelized; investigated.
Davis Monthan, Ariz.: channelized; investigated.
Homestead, Fla.: channelized; investigated.
Hunter, Ga.: channelized; investigated.
Little Rock, Ark.: channelized; investigated.
MacDill, Fla.: channelized; investigated.
March, Calif.: channelized; investigated.
Pinecastle, Fla.: channelized; investigated.
Fairchild, Wash.: channelized; will be investigated (recent).
Walker, N. Mex.: channelized; currently being investigated.
Castle, Calif.: Not channelized; investigated.
Tinker, Okla.: Not channelized; investigated.
Westover, Mass.: Not channelized; will be investigated (recent).

Light duty

Luke, Ariz.: investigated.
Yuma, Ariz.: investigated.
Myrtle Beach, S. C.: Currently being investigated.

RIGID PAVEMENTS

Five cases reported to OCE: 5 heavy load; 0 light load.
Four cases have been investigated.
One case is currently being investigated.

Heavy duty

Lake Charles, La.: channelized; investigated.
Forbes, Kans.: channelized; investigated.
Castle, Calif.: channelized; currently being investigated.
Dow, Maine: not channelized; investigated.
Smoky Hill, Kans.: Not channelized; investigated.

Tabulation of airfields reported to Chief of Engineers as being deficient due to B–47, KC–97, B–36, and B–52 traffic

FLEXIBLE PAVEMENTS—HEAVY DUTY

Air Force base	Traffic	Area	Remarks
Altus, Okla	B–47 and KC–97	Channelized	Apron failed in channelized area (shear in binder, base, and subbase); specifications not met; criteria revised to make more foolproof. (1).
Davis-Monthan, Ariz	do	do	Taxiway, 25 feet of center of flexible taxiway was replaced with PCC. Flexible pavement each side of PCC is depressed. (2). (Plastic flow of wearing and binder courses.) (3).
Homestead, Fla	do	do	Apron and taxiway depressed areas due to soft material underneath (densification). (4).
Hunter, Ga	do	do	Taxiway depressed and cracked in, and adjacent to, test section (densification). (4)
Little Rock, Ark	do	do	Taxiway depressed at juncture with rigid pavement (densification). (4)
MacDill, Fla	do	do	Taxiway depressed along centerline (densification (4) and plastic flow (3) in overlay built by AF).
March, Calif	do	do	Taxiway depressed (densification of subgrade). (4)
Pinecastle, Fla	B–47	Channelized and nonchannelized	Original taxiway depressed (densification of subgrade. Runway depressed (densification at grade stakes). (4)
Fairchild, Wash	B–36	Channelized	Taxiway rutting (reported to OCE June 19, 1957; will be investigated).
Walker, N. Mex	B–36, B–47, and KC–97	do	Taxiway depressed. (Currently being investigated. B–52 scheduled for this base.)
Castle, Calif	B–47 and B–52	Nonchannelized	Runway depressed at juncture to old rigid slab at end of runway; depression about 3 (5) inches deep for distance of 80 feet (settlement).
Tinker, Okla	B–47	do	Runway base course shear failure in flexible overlay immediately after construction. (1) (Specification not met; criteria revised to make more foolproof.)
Westover, Mass	B–47 and B–52	do	Runway depressions. (Reported to OCE June 19, 1957; will be investigated.)

RIGID PAVEMENTS—HEAVY DUTY

Lake Charles, La	B–47	Channelized	Taxiway and runway end cracked due to channelized traffic.
Forbes, Kans	do	do	Do.
Castle, Calif	B–47 and B–52	do	Original taxiway to stub parking cracked due to channelization and overload. (Currently being investigated.)
Dow, Maine	No traffic	Nonchannelized	Apron cracked due to frost action in base course. (Improper base materials.) (6)
Smoky Hill, Kans	B–47 and KC–97	do	Runway, spalling of keyed joints in PCC overlay. (Probably poor construction practices.) (7)

FLEXIBLE PAVEMENTS—LIGHT DUTY

Luke, Ariz	F–84		Taxiway turns into runway. (Bleeding due to high asphalt content. Contamination of asphalt from asphalt plant.) (8)
Yuma, Ariz	F–86		Runway and taxiway. (Bleeding due to high asphalt content.) (9)
Myrtle Beach, S. C	C–121, C–54, and fighter aircraft		Taxiway. (Distortion and cracking of AC, cause not known; currently being investigated.)

NOTE.—None of the bases listed were designed for channelized traffic or for the B–52 loading.

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TABULATION OF AIRFIELDS REPORTED TO CHIEF OF ENGINEERS AS BEING DEFICIENT DUE TO B–47, KC–97, B–36 AND B–52 TRAFFIC

(1) (Shear in binder base and subbase.) Is the displacement of these layers. The materials are pushed from their constructed position by load and tire pressure.

(2) (Flexible pavement each side of PCC is depressed.) The flexible pavement is compacted adjacent to the concrete pavement due to aircraft traffic whereas the concrete is undisturbed.

(3) (Plastic flow of wearing and binder courses.) Plastic flow is the displacement or movement of wearing and binder courses. This action occurs when a pavement has been compacted to the extent that all voids in the mixture are filled. Since neither the aggregate nor the asphalt can be compressed further, continued stressing causes the material to flow.

(4) (Densification.) Compaction of the material caused by aircraft traffic without shear effects.

(5) (Settlement.) This again is compaction of the material caused by aircraft traffic but may include shear effects.

(6) (Improper base materials.) The base materials were supposed to be non-frost-active, i. e., fine-grained soils which draw water to build ice lenses were supposed to be removed. However, they were not uniformly removed. Spots throughout the base contained excess fines.

(7) (Probably poor construction practices.) Stripping the forms while the concrete was green is the probable poor construction practice.

(8) (Bleeding due to high asphalt content. Contamination of asphalt from asphalt plant.) Fuel oil used to operate the plant spilled or leaked into the asphalt tank which provided asphalt for the asphaltic concrete mixture. In addition, the asphalt content was high.

(9) (Bleeding due to high asphalt content.) Asphalt runs or flows when subjected to high temperature or aircraft traffic when there is too much of it in the mixture.

General WILSON. That completes my prepared statement, sir.

Mr. HÉBERT. Thank you very much. It is a most comprehensive statement. And I have just one question to ask you to sum up.

In other words, the position of the Corps of Engineers in this situation is that the competency of rigid pavement is known and has been proved?

General WILSON. Yes, sir.

Mr. HÉBERT. Whereas, the competency of the flexible pavement has not as yet been proved, but quite possibly it can be made to stand up under this channelized traffic or to take these heavy bombers?

General WILSON. I would like to modify your last part.

Mr. HÉBERT. Yes, sir.

General WILSON. The competency of flexible to carry the B–52 or heavier loads has not as yet been proved up to our satisfaction, although it is not improbable that we will be able to develop it.

Mr. HÉBERT. Eventually, do it?

General WILSON. Yes, sir.

Mr. HÉBERT. Therefore, that being the fact, as of now, the position then for the development or the construction of airfields is to take the proven product. You can't wait to prove the unproven; is that a fair statement? In other words, you have to construct the airfields now.

General WILSON. Yes, sir.

Mr. HÉBERT. You can't delay until you prove the unproven product?

General WILSON. That is correct, sir.

Mr. HÉBERT. You must take the proven product; is that correct?

General WILSON. That is correct, as far as it affects those loadings; yes, sir.

Mr. HÉBERT. And projecting the problem into the future, if the day should come that the flexible pavement could be proved equal to the rigid pavement, then of course, both would be in a competitive position.

General WILSON. Well, the Chief of Engineers feels that the determination of the actual surface selected in terms of operational requirements is a problem that the Air Force should make.

We, the engineers for the Air Force, should present the facts to them, as to the availability of the types of pavement, and the relative costs, but that if they decide to make that determination for operational reasons, for reasons of types of plane that they have, or the operational characteristics of them they require a certain one, we don't believe we are in a position to tell them we won't build what they specify.

Mr. HÉBERT. That is correct.

You are not the evaluating agency. You merely present the facts and decisions are left to the Air Force.

General WILSON. Yes, sir; that is the point I am making.

Mr. HÉBERT. But the facts would indicate that sometime in the future you could overcome the deficiencies of the flexible paving?

General WILSON. We feel that we have very reasonable chances of overcoming the load-carrying characteristics for at least the B–52 and probably for heavier planes.

I must mention again, however, that there are these other things, such as blast effect and spillage and things of that nature, which could be a serious deterrent as to which surface to use, as the load-carrying capacity.

Mr. HÉBERT. That is correct.

Now, are you in position, General, to give the committee any information as to the relative costs?

General WILSON. Yes, sir.

Mr. HÉBERT. Would you please do that?

General WILSON. I will use the same figures on cost that Mr. Ferry of the Air Force has presented, sir. I can explain them further.

His figures, and ours are the facts. Therefore, they are the same figures. You have those available.

At any rate, I will read what we have on that, sir.

Mr. COURTNEY. Mr. Chairman, those appear on page 5 of Mr. Ferry's statement, I take it?

General WILSON. That is correct.

I will not repeat them, then, except to summarize.

Mr. HÉBERT. That is correct.

General WILSON. In trying to evaluate the relative cost, we have taken the period 1952, 1953, and 1954 and through 1955, and we have averaged the actual contract costs, again exclusive of anything done underneath the pavement itself, that is the subbase and base, and for rigid pavements, heavy-load rigid pavement, which again in most instances are referring to a design which is actually not capable of carrying the B–47 because it was not designed to take care of channelization, but it is close——

Mr. HÉBERT. Yes.

General WILSON. The average is $6.89 per square yard. The heavy-load flexible pavements during that same period, as indicated there, averaged $3.67.

Mr. HÉBERT. Approximately half.

General WILSON. A little more than half. That ran pretty consistently. Both rigid and flexible, due to volume, improvements in equipment, and so on and so forth, were gradually dropping in cost during that period—almost. There was one instance where it was a little lower, earlier. But generally speaking, the costs in both were dropping.

Mr. HÉBERT. The costs in both were dropping.

General WILSON. In both were dropping slightly.

Mr. HÉBERT. How about the difference?

General WILSON. The difference was staying relatively the same.

Mr. HÉBERT. All right. Of course, you have stated you do not take into consideration your subsurface construction?

General WILSON. Yes, sir.

Mr. HÉBERT. Is subsurface construction more costly for the flexible pavement than for the rigid pavement?

General WILSON. In our most recent criteria, there is a little more consolidation of the subgrade in the case of flexible than in the case of rigid. But I think essentially you can say when you throw in the drainage structures and the excavation and removal of materials and bringing it in, that essentially we are talking the same order of magnitude.

Mr. HÉBERT. Now, a third question, and the conclusion of that.

In the maintenance, in the projected long-range picture, would the difference between the cost of concrete and asphalt or the rigid pavement to the flexible pavement be overcome by the higher original cost of the rigid pavement?

General WILSON. I am not competent to answer that question, sir.

We would get our information on costs of maintenance from the Air Force. I could only give a guess.

Mr. HÉBERT. Well, you, as an engineer—what would be your guess?

General WILSON. If you will keep the load of the airplane fixed and not change the wheels, the tire pressure, et cetera, so that we are talking about a fixed loading, I would say without question that it would be more economical to build asphaltic and repair it for a period of a 20-year life.

However, if you look at what has happened, nothing has stayed static.

The load keeps going up. Even the B–52; the first issue was lighter than the current issue.

If you look at that, I feel also that there is a factor that the rigid has a better chance of carrying overloads successfully than the flexible. They can both carry some overload, but just the nature of the thing—the rigid is cemented together, and bridges to a certain extent more than the flexible.

The flexible is more subject to shear, which means that the courses themselves can slide down. In that aspect of it, the rigid has a better chance of outguessing the future. So it is a pretty tough determination to make, sir. The Air Force has that problem. We would have the problem if they asked us.

Mr. GAVIN. They haven't asked you?

General WILSON. Well, we advise with them, sir. We have not been asked to concur or not concur in these things. But we certainly advise with them.

Mr. HESS. There is no question, General, is there, but what there is a real need for flexible pavement?

General WILSON. I don't question the need for it. From an engineering viewpoint, there is no question in my mind we must have a criteria, a knowledge, and an ability, to build it.

If that answers your question?

Mr. HESS. Well, there are certain areas. Where we have airfields, that we must use flexible pavement, that is right; isn't it?

General WILSON. I am certain that the Air Force, in my discussions over the past, would agree with that also. There are certain places——

Mr. HESS. For that reason, we must continue every experiment we can possibly carry on.

General WILSON. My view is we must continue every experiment and carry it on.

Mr. HESS. You are doing just that.

General WILSON. We are doing it within the limit of the funds which the Air Force can give us, or has given us.

Mr. HÉBERT. That always comes into the picture, doesn't it, General?

General WILSON. Yes, sir. The dollar always enters at some stage.

Mr. HESS. Did I understand you to say, General, that the subbase for flexible and the subbase for rigid would cost approximately the same?

General WILSON. Yes, sir.

There is, as I say, a slightly greater effort as a result of what you have been listening to and in an attempt to develop the new designs.

Mr. HESS. And the causes of failure here that have been reported here by Colonel Alexander—you heard them, I believe?

General WILSON. Yes.

Mr. HESS. Were to the surface, were they not; they weren't to the base or to the subbase?

General WILSON. I am not sure I can agree with that, sir. I would rather answer that in another way.

I would rather have you look at the table we have there. They are covering the same fields.

Mr. HESS. All right. I notice here that everything seems to be channelized.

General WILSON. Yes, sir.

Mr. HESS. That is the surface, then; isn't it?

General WILSON. No, sir, no, sir. That is the point I would like to make.

I will admit that this channelized traffic business is a—it is difficult to get the whole point in it. Frankly, it was sufficiently difficult to get the point that neither the Air Force nor the engineers nor anybody else got the point before it happened.

This channelized traffic—I might make a very poor analogy, but it is an exhaustion or a fatigue sort of thing. It is like—if I were asked to lift a 1-pound weight a hundred times, I could lift a 1-pound weight

a hundred times but at the end of it I would be tired, but if somebody said, "You got to lift it 25 more times," I could do it.

But if somebody asked me to lift a 50-pound weight 10 times, I might make it, but at the end of that time, if they wanted it another 5 times, I am not too sure that I would have the capability of doing it.

It is the effect of many things.

It is the effect of the heavy load and the number of times it hits that particular small piece of pavement, and the frequency with which it hits that small piece of pavement, or in effect the pressure of the tire, which affects how much area is laying on the pavement and distributing the load.

All those elements enter into this thing we try and call channelization.

Now, the effects are you can, as a result of that, overuse the pavement in a short period of time, based on what it was designed for.

So actually you are getting in some cases actual shear, just in that one track, in all the layers, clear down to the grade, which are actually moving.

They may be compacting. They may be actually moving down pretty much in place. Or the subgrade itself, which was designed to carry this load—a lesser load on that particular spot, in that it was a lesser number of times it hit there—for 20 years and it has reached this point of exhaustion in 3 years.

Mr. GAVIN. It gives away.

General WILSON. It gives away. So where we said channelization, most of those, which I tried to cover on the very last sheet, would not be chargeable to the little layer of asphalt on the top. But on the other hand, as the Air Force showed yesterday, and as we could illustrate with a chart, if you desire, the job of producing a runway or a taxiway or something involves going all the way down to the subgrade, and coming all the way up through this little wearing surface on the top.

So when you are criticizing or commenting on flexible pavement, you are really not just commenting on this layer.

Now, as I said in my statement, as of right this minute we feel that we have proved up everything in this whole sandwich below the actual top layer, for the B–47. And we feel that probably we have proved it for the B–52. But we are not positive as yet. We want to go further.

Mr. HESS. What about the weight of the B–58?

Have you any idea what the weight will be?

Are you working on that problem now?

General WILSON. We are working on a load characteristic of about—I think it is 325,000 instead of 240,000 pounds, which was gotten in consultation with the Air Force for just a target in the future. They have given us characteristics as to possible wheels and so forth and so on.

I don't believe I can say we are aiming at a particular aircraft, although it could be.

But within the limit of the funds we are working on it.

We are not very far as yet. I would like to make a point here, that all design of all pavements is different than the design of a steel structure.

It is not true-engineered theory worked out by mathematics and the like, which can go back to the source and always be proven. It has to be empirical. The way all pavement designs have developed is you have gone out and built something, and seen what happened.

That started way back when. If it began to fail, they did something, back to the days of the Romans.

Now, the point I am making is that it is an engineering subject, but it is not a scientific subject to the extent that other types of construction are.

We have to find out by a little bit of guess; that is, guessing the way the curve will go, try it out and see what happens, prove that out or disprove it, and then extend our curves.

In other words, you have to develop your design criteria for both concrete and asphalt empirically.

So to answer your question more directly, I personally feel we should put more emphasis on trying to hit some of these points in the upper part of the curve beyond our present experience. We are doing it. Whether the Air Force will be able to give us enough money to proceed at the rate I would like, I don't know, sir.

Mr. HESS. Of course, we will reach that point, at the peak, and then we will start going on down when the guided missile comes in, and we will have no need for pavement to take these weights.

General WILSON. We may not.

On the other hand, at the time it is conceivable that you get a guided missile that is heavy enough that you have to have something leading up to someplace that requires that.

In other words, as information on which to do other kinds of things, it probably will be of value.

Mr. MILLER. It will be worth while.

Mr. HÉBERT. Mr. Fisher.

Mr. FISHER. Can the Corps of Engineers now state unequivocally that they know how to design and construct a flexible pavement providing satisfactory service on B–52 fields for a reasonable length of time.

General WILSON. No, sir.

Mr. FISHER. General, I think so far as the knowledge you have gained about the flexible pavement is concerned, it is pretty well summarized here in one sentence of your statement, on page 4, where you say, "the latest"—and I believe I will reread it just for emphasis, just to pinpoint it:

> The latest revisions of design criteria, July 1956, for the asphaltic concrete layer currently being traffic-tested at the Waterways Experiment Station should result in pavements that are safe for the B–47 loading and may well be safe for the B–52 loading from the standpoint of displacement under traffic.

Then you went on to say:

> It should be emphasized, however, that further research and experience are required to prove up this load-carrying capability and to establish whether or not the desired pavement life can be attained due to a potential reduction in durability associated with these new surface layer criteria.

And then the concluding sentence in the next paragraph, you say:

> Further investigation is definitely required before any design or construction for these extremely heavy loadings is initiated.

General WILSON. Yes, sir.

Mr. FISHER. Now, can you tell us briefly what progress is being made up to this time in this research study at Vicksburg and elsewhere? Where do you stand on it? Will it take another year or 2 years, or can you estimate the point you have arrived at in answering the question that you raise there?

General WILSON. I can estimate that, sir, generally. I would prefer to leave any detail on it to be discussed in my third phase, as I indicated, by the people here who are actually running it.

As far as the B–52 goes, I think we are on the brink. It isn't very long.

As far as proving the life—now here is the point in that. We are trying not to be too technical in this presentation.

The problem of the little surface layer is related to the amount of asphalt you put in. To some degree, the more asphalt you put in it the more cohesive it is. But also the more asphalt you have in it the more it is apt to give or bleed, or show detrimental effects from too much overload. So you have to get a balance.

Now the improvement toward carrying the load consists in reducing the asphalt content. But that in turn makes it—the tendency of that will be to have less cohesive effect and may result in a raveling result or shorten the actual durability.

Now again I am saying "may."

I would say we have to do some more of these accelerated tests, some of which are underway, as he will explain to you. Some of them are reaching a point of being able to determine it. Others haven't reached that stage.

Mr. FISHER. Now, in regard to the asphalt concrete, I assume from our hearing here 2 or 3 years ago, and what has been said here that a great deal of improvement in the quality and capability of asphalt concrete is taking place. In other words, can you say that they have a better grade, more capable of meeting the current problems today, than they had, say, 5 years ago as a result of what they are doing in improving the capability of it? Can you comment on that?

General WILSON. Yes, sir, I can comment on it.

I would say that we are in pretty bad shape if we are not improving all the time in all these materials. We are learning more.

Your answer is generally correct—your question as stated is generally correct.

Things that have changed are the type of loadings and the weights. So that 5 years ago nobody was trying to solve that particular problem. We may have been in a position to have come as close to solving it 5 years ago as we are now. I am not competent to answer that portion of it. But as the horizon has gotten tougher, the state of knowledge due to both the industry and our engineering people and the results of the Air Force people work and everybody else, it has improved; yes, sir.

Mr. FISHER. One other question. This thought occurred to me.

This channelized traffic is the No. 1 problem to me. It is causing a lot of this trouble.

General WILSON. It is the thing which none of us were aware of as little as maybe 3 years ago at the most.

Mr. FISHER. Now from an engineering standpoint, would it be—probably it isn't, but I will expose my ignorance by at least asking

the question. Would it be feasible at all from an engineering standpoint to put rigid paving along the area that is channelized and which is apparently a rather limited area, and then the flexible type on either side?

General WILSON. I believe I can answer that positively. Yes, sir; it is engineeringly feasible. The actual joint between those two will be a source of concern for all time.

You will notice that in many of these here—if you got into the details you would find where they talk about going from one to the other, where they have some distress. There will be a tendency for it. I believe it can be overcome in most instances. But it will be a matter which no one can guarantee the user of the airplane that there may not be some slight depression, particularly adjoining where the flexible touches the rigid. Now whether that can be operationally accepted by the current aircraft or by what might show up in the future I can't answer, as to that portion of it.

Mr. FISHER. I take it the possibility has not been explored?

General WILSON. No, sir; it has been explored. As a matter of fact, I believe at one airfield in North Dakota, Minot, that the Air Force has suggested to us that we do that, or has given us instructions to, and we are doing so. It will in effect, in time, be a demonstration of that particular situation, with those particular aggregates and that particular amount of freezing and the particular loads that use it, whether it will work. But enough of that kind of information will give us our empirical information.

Mr. FISHER. Of course, if that could be made to work out, it would result in the using of more asphalt and certainly in reducing the overall cost as well.

General WILSON. It could well reduce the cost.

Now, of course, in some areas you will find concrete may be no more costly than the asphalt anyhow. But those are not extensive.

Mr. FISHER. Well, based on these figures you gave us awhile ago.

General WILSON. Those are nationwide. That is correct.

It is also true, if you have a large paving program, that if there is too small a proportion of rigid or flexible to be built, it may not pay to bring in the particular equipment for that type. That has to be decided in each instance.

But I think there is a good probability of being able to develop, in effect, a narrow lane capable of carrying it.

There is the point I want to make. When we talk about our new criteria for the channelized traffic, actually that is what we are doing. Not in terms of rigid or flexible, but in terms of increased strength in that narrow lane. We are increasing the thickness and strength in that lane as opposed to the other portions in order to try to be economical. In other words, we haven't built the whole runway or taxiway to the full thickness that would be required.

Mr. FISHER. I see. In other words, you have a stronger and more durable base in the channelized area than you do——

General WILSON. A complete pavement, I will call it that.

Mr. FISHER. I see.

General WILSON. Including the whole works.

In other words, following out the present criteria we are following, we have what we call three types of traffic areas, A, B, and C, and they

cover those areas. For instance, in a primary taxiway area the type A area is only about 25 feet wide—25 feet through the center of this taxiway being deliberately under the new criteria being strengthened. That does not apply to any one of the fields that are listed in this business here. That is where we are in trouble. We didn't visualize or know, nor did the Air Force, that with the advent of these particular planes and the change in their methods of operation, that they would follow this same line.

Mr. FISHER. And that you described as being about 25 feet?

General WILSON. Yes, sir, I think 25 feet is our present criteria.

Mr. FISHER. How wide is the present runway?

General WILSON. Well, it would be 75 feet on either side of it, 25 feet of which——

Mr. FISHER. Twenty-five feet is the channelized portion?

General WILSON. Wait. Let me get myself clear. The total width is 75 feet. The reinforced portion of the taxiway is 25 feet.

It does apply also to some extent, sir, at the end of the runways where you have always had—not always, but where in recent years we have placed portland cement. Even there we thicken or strengthen that portion which the planes roll out on, get set on, and get moving on, as opposed to the whole full width. The full width of that pavement—we don't spend the money to make it full strength there.

Mr. FISHER. I think that is all.

Mr. HÉBERT. Mr. Gavin.

Mr. GAVIN. Well, I conclude from what you say, General, that channelization is one problem, and the subbase and substructure is also a problem to be considered?

General WILSON. Yes, sir.

Mr. GAVIN. In developing and planning and designing an airbase, how extensive do they follow through in testing the substructure to ascertain what is underneath before they go in there? Does the Department of the Army design the airbases or does the Department of the Air Force design them themselves?

General WILSON. The ones that we build for the Air Force—the Navy is also a construction agent for the Air Force. The ones that we build we are responsible for the design.

Mr. GAVIN. The ones you build.

General WILSON. The location of the field is a determination for the Air Force.

Mr. GAVIN. Yes.

General WILSON. The place where they want it.

Mr. GAVIN. That is the location, the site.

General WILSON. If we don't think it is a good area—I mean by that if we think by minor movement we can get a better condition, we so recommend to the Air Force, and normally we get an agreement. But the determination that they want an airfield here is an Air Force problem.

Mr. GAVIN. I think that is an important matter to consider. I can't imagine why more consideration isn't given when they are determining on the location of an airbase to find out what they have underneath, where they are going to come in with these big 47's and 52's to land. I think channelization is a problem. I think that substruc-

ture and subbase is a very, very important problem. And nobody, as has been indicated here, has yet begun to realize that these heavy planes that are being developed are going to necessarily change the design of the pavement and substructure and everything. You just go in and decide on a location and build an airbase and lay out the strip.

I think this hearing here will indicate some of the things that must be done to get the best possible results.

Now I want to ask you: Has the Air Force made enough money available for you to conduct the type of research and study program to reach a solution of this problem at an early date?

General WILSON. You are talking of the pavement problem or the location of an airfield?

Mr. GAVIN. I am talking about the rigid and flexible pavement problem. Now that is the one that seems to be of primary importance.

General WILSON. I would like to answer both of your questions if I can. I will take the latter one first, the question of the money on the research.

Mr. GAVIN. The reason I am asking it: They are going to expect you or charge you, who are handling their affairs, to come up with the answer. You are not going to come up with the answer unless you have enough money available to do work and carry on the study. Go ahead.

General WILSON. Well my answer to that, to start with, Mr. Gavin, would be that no one who is charged with a problem and whose life is tied up in the problem daily ever thinks he has enough money. There is always more that he could be doing simultaneously to really solve everything.

Mr. GAVIN. We understand that. We are on the Armed Services Committee.

General WILSON. So I am on the side of the man who wants the money and isn't parceling it out.

I would say up to now, generally speaking, I think the Air Force has given us very reasonable treatment. The amount of money that was quoted yesterday I can't account for, sir, but we have had an appreciable amount of money on research in both of these fields.

I have taken the last 5 years and attempted to correlate it. Over the last 5 years it has run about $440,000 for flexible and $400,000 for rigid. The average—I mean that is the average over the 5 years. Actually in 1957 we got $500,000 for flexible and $750,000 for rigid.

So it was greater than the average.

Now we are asking in 1958—and we realize what the conditions are with regard to funds. But in terms of trying to get them answered soon enough, we are asking for $800,000 for flexible and $536,000 for rigid.

Mr. GAVIN. Well, I think you are proceeding very well.

General WILSON. Now with regard to the other portion of your statement, I don't believe it has been made clear the extent to which this exploration is carried out.

I am giving this to you without looking into it to be factual, but generally speaking the Air Force has boards, including their own engineering personnel and in some instances I believe they have con-

sultants and on occasion they invite us to be represented on the board, which looks into this airfield site.

Now on further occasion they ask us to make certain subsurface investigations for them, before they make a final determination. And certainly when they give us the job and say, "This is where we want it," it is our standard procedure to get out there and take borings. The number of borings and the amount of money you spend on it depends on what you find.

If it appears that the surface is fairly uniform underneath in the various layers, then you take a reasonable number, but no further, because there is no need to keep on putting the holes down. If you find it is variable, it is within the prerogative of our district engineer to take additional——

Mr. GAVIN. It wouldn't be too much of a job to take a test boring on the entire length of an airstrip, would it?

General WILSON. My point is we do it on the entire length. But whether you take it every 10 feet or 100 feet on 3 miles of runway—we would start out by spotting them at a reasonable distance both in length and in width. If the evaluation of those results leads you to be concerned, then you go in and put more in.

Mr. GAVIN. I understand.

General WILSON. Now we are not by any means perfect, and we have made mistakes. So we haven't always found out all there is to know.

Again, as in any kind of research, the man directly responsible would like to put holes down about 6 inches apart and know just exactly what exists every place.

Mr. GAVIN. It would be all right with me. If we are going to build a $75 million or $100 million airbase, I wouldn't mind seeing them put down there.

General WILSON. The cost runs up pretty fast.

Mr. GAVIN. It may be, but we have a big investment, and we have the rehabilitation and protection of it.

General WILSON. Admittedly, it is our responsibility, and to take the engineering judgment. Actually that is decentralized down to the district engineer, to make that determination. If he runs into trouble, if he is worried, he normally gets in touch with his division engineer, and with my specialist in the Chief of Engineers office. In other words, we try to bring the brains in necessary to solve it. And in many instances they say, "Well, go back and take more."

Mr. GAVIN. The reason I ask—here several years ago they were going to locate a base up in a certain area. In fact, they had all the plans and specifications all set. The reason they didn't locate it: They found there was a certain type of rock formation, or formations, underneath, and they just couldn't work it out. But they had gone in there.

My thought was they should have made the test borings to determine what substructure was there before they even started to develop their plans and specifications and layout and ask for authorization to proceed with the work.

General WILSON. I can't quarrel with that, sir. I do know that time also enters into many of these. Operational reasons come along, which means that you have a time to produce them and a finished result.

So you can't always take as long as you would like in these. You do certain things simultaneously. Which sometimes results in costing money. But on the other hand, in most of the cases it results in meeting the requirement on time rather than being behind.

Mr. GAVIN. Now I want to ask this question. We got the Department of United States engineers charged with the responsibility for the engineering program for all branches of the service, or at least the Army——

General WILSON. No, sir, not——

Mr. GAVIN. Not all branches. We know the Navy—well the Air Force nearly had their engineering branch a couple of years ago, too, don't forget that.

General WILSON. Well, the Air Force also have the right to use the Navy and make their own determination.

Mr. GAVIN. Right.

General WILSON. As to whether it is us or them.

Mr. GAVIN. And they use the Navy.

General WILSON. Yes, sir.

Mr. GAVIN. They used the Navy in the Spanish bases.

General WILSON. Yes, sir.

Mr. GAVIN. When we had the Army right across the sea in North Africa and we could have moved over there lock, stock, and barrel, they decided to give it to the Navy. That was that. I was not too happy about that. But you are talking about the Air Force bringing in civilian engineers.

Now the way I feel about it as a layman: Here we have the United States engineers. The Air Force want an airbase. They determine on a location. From then on I would say, "Here, engineers, you take the job. It is your job. Now you work it out." Why do we have to bring in outside sources to confer and discuss and lay out, when we have the engineers? If the Air Force charged you and then if there were any mistakes come up like this rigid and flexible now, they could say, "We don't know, that is the engineers problem, and not ours. We gave them the job to do."

But no, they are going outside. I think that these problems should be given to the United States Engineers, who would be charged with the responsibility of solving them. That is my personal opinion.

Now let me ask you this. Do you think from the studies that you are carrying on and making that eventually, in the near future, you can design and construct a flexible pavement that will be able to stand the continuous traffic by heavy aircraft such as the B–52? Are you coming along to a point where you are going to be able to solve that problem?

General WILSON. I can answer that positively, sir, that I think we are as long as you are talking about the B–52.

But on none of these pavements can I say that we will be able to carry what somebody may be flying off of them 10 years from now.

Mr. GAVIN. But you are leaving nothing undone to get that problem licked, is that right?

General WILSON. Yes, sir.

Mr. GAVIN. I have no other questions.

Mr. HÉBERT. Mr. Miller.

Mr. MILLER. Mr. Hardy was ahead of me.

Mr. HÉBERT. You have been asking for recognition.

Mr. MILLER. I only wanted to clear up 1 or 2 things, General.

General WILSON. Yes, sir.

Mr. MILLER. Going through your statement here I noticed at Luke, Ariz., and Yuma, Ariz., you qualify the failures of the flexible pavement there by—in the footnote, showing that there was bleeding due to high asphalt content and contamination of the asphalt from the asphalt plant in one case, and in the other the asphalt runs or flows were subjected to high temperature. Should those be charged to the basic failure of the flexible type or asphaltic type pavement? I hope you won't be too technical if I use asphalt instead of flexible.

General WILSON. Yes.

Mr. MILLER. When they are really human errors that enter in.

General WILSON. No, sir, except for this. You wouldn't have that type of a result showing up if you had used rigid. You couldn't. Now you could have other type of results in human errors in a rigid-type pavement.

Mr. MILLER. Well, you show that here.

General WILSON. That is right.

Mr. MILLER. I was going to bring that out next. You are accepting the human errors, then, in evaluating——

General WILSON. Unfortunately most of the human errors here can be charged to me and my organization, so I have to accept them.

Mr. MILLER. Another thing. In looking at this table that Mr. Ferry uses, in the last two instances you show that the unit cost was 7.58 for the heavy rigid pavement and 6.08 for heavy load flexible pavement, but there is also a footnote there that said "The latter cost reflects two unusual jobs."

General WILSON. Yes, sir.

Mr. MILLER. One at Minot, S. Dak., and one at Eielson Air Force Base, Alaska, which increased the cost of the flexible pavement percentage.

Just two instances don't reflect too much the comparative costs in those two, do they?

General WILSON. Mr. Miller, I really never quite completed answering the question on cost. We got away from it.

We would not like to use that $9.40 figure for those reasons.

Mr. MILLER. I just wanted to bring that out. That throws it out—that is not a median cost in any sense of the word.

General WILSON. No, sir. In those particular instances—I don't remember exactly, but the rigid—our estimate is that the rigid pavement at those two fields would have cost $12 or $13 a square yard.

Mr. MILLER. Yes.

General WILSON. If we had used rigid.

Mr. MILLER. I just want to ask 1 or 2 more questions and then I am through.

Isn't it true, you mentioned Bermuda, already large areas in the world where you can't get good concrete aggregates that make the rigid—and if you don't get good concrete aggregates, you are not going to be too happy about rigid pavement, are you?

General WILSON. That is correct, sir. You can always get it if you will spend enough dollars, sir.

Mr. MILLER. Well, I have in mind when we were in Saudi Arabia last year, one of the engineers of Becthel Co. told me, in looking over the plain, "Here is lots of rocks, but we don't get good concrete aggre-

gates because all of the fines have been blown away." Isn't that true?

General WILSON. There are lots of places where you have rock where it is not good rock.

Mr. MILLER. Good rock, or where you might have apparently lots of sand that isn't good sand for concrete.

General WILSON. Oh, definitely; yes, sir.

Mr. MILLER. So that is a factor.

Now I asked the other day, or yesterday asked one of the gentlemen whether he felt we were at the end of the rope in this thing, if we could say today we could adopt specifications that are going to be good 10 years from now. Do you feel that way?

General WILSON. I had the advantage of hearing his answer, sir. I have already really answered that question once. No, sir.

Mr. MILLER. I know you have. I just wanted to point it up, General.

Mr. HÉBERT. Mr. Hardy.

Mr. HARDY. Mr. Chairman, I am going to be very brief. But I want to compliment the general and express appreciation for what to me has been the clearest testimony we have had, that we have listened to.

Mr. MILLER. If you will pardon me, I would like to join you in that statement. I, too, would like to say that.

Mr. HARDY. We are not engineers, and certainly I never want to leave the impression that I am trying to exercise any engineering judgment, but I do appreciate testimony, General, that indicates that some of you people who are experts in this field have evaluated the factors that really go into your consideration and arrived at decisions that are based on engineering data.

Now, that is the thing that really impresses me with this presentation we have had here this morning. Now, I just want to clarify in my own understanding of some of your testimony. Did I understand that the engineers have developed design specifications for rigid pavement construction that met all of the requirements of the heaviest aircraft loads used by the Air Force today?

General WILSON. Yes, sir; I believe that is correct.

Mr. HARDY. Did I further understand——

General WILSON. Wait a minute now. He said of the heaviest aircraft used to date. That is correct, sir. My statement is correct.

Mr. MILLER. "Today" is important.

Mr. HARDY. Did I further understand that you have developed criteria or specifications for subgrade construction with respect to flexible pavements which would meet the requirements of the aircraft in use today?

General WILSON. I am positive with regard to the B–47 and I am fairly certain with regard to the B–52, but I would like to have additional proving it up before we would want to say that we are here.

Mr. HARDY. Did I further understand—that is clear. And did I further understand that your surface treatment—that is, your thin top coating—has not been proven up yet with respect to requirements for either the B–47 or the B–52?

General WILSON. I will tell you right now that when our technicians get on the stand in some instances they may feel they have

gotten far enough. I still would like a little more proof for the B–47.

But I feel fairly certain that we are there with the B–47.

With the B–52, I feel that we are going to get there, but we are not quite there yet, although, again, my technicians may say that in their opinion they have something that will hold up.

Now, whether—I personally feel that their answer is honest, legitimate, and proper from the man responsible for developing this, and in turn I should see that we do a little more proving it up before I would want to tell the Air Force "Here it is."

Mr. HARDY. With respect to your discussion of the cost of subbase construction, you indicated that there was not a great deal of difference in that cost with respect to either the rigid or the flexible, as between the rigid and the flexible——

General WILSON. We are talking subgrade, sir.

Mr. HARDY. Subgrade.

General WILSON. There is a vast difference.

Mr. HARDY. All right.

That is the thing that I want to understand. I want to get an explanation of the difference as represented in the 4 inches on poor bearing ground, and 6 feet, in the illustration presented by the Air Force yesterday.

Maybe I didn't understand it.

General WILSON. I don't have available, sir, the one they had yesterday. I guess it is here. But I believe if you will look at that chart, I just handed you—these are based on the same types of conditions.

Mr. HARDY. Yes. The one over on the left——

General WILSON. I would like to make the point here that I believe the Air Force chart is based on a type C pavement, and the one I am handing you is type A. Type A would be where we are carrying the channelized traffic.

Mr. HARDY. The one thing that bothered me, General, is in connection with the chart on the left.

General WILSON. Yes, sir.

Mr. HARDY. It would certainly seem to me that the subbase or subgrade, either one that you take in that case——

General WILSON. Well, there are two different things, sir.

Mr. HARDY. Well, that is what I would like to understand.

General WILSON. The subgrade in effect is the material that was there to begin with. As a result of experience over the last few years, we do something to that subgrade nowadays.

We compact it to a greater extent under flexible than we do under rigid, but we still compact the ground that is left there when you get through clearing it off.

The subbase is brought in. It is material added, normally.

Mr. HARDY. I thought when we were talking about the cost a while ago—I was thinking in terms of this 72 inches, as compared to the 4 inches in your statement, and that is what I couldn't reconcile.

General WILSON. No, sir.

What I am saying is, if you will look at that little one I just gave you—on the right-hand side, under flexible pavement, where you have a relatively good soil condition, the thickness of the finished job is only about 30 inches in that particular instance.

But you will notice that we have compacted the subgrade for a considerable distance below that.

Mr. HARDY. Is there any relationship that you can tie down in the cost of your preparation, whether it is compacting subgrade or supplying subbase—is there any relationship that is reasonably permanent between those costs with respect to rigid and flexible pavement?

General WILSON. I believe I am correct in stating that while in the example of my right-hand figure a good foundation with a flexible pavement—there will be a little more spent in compacting that subgrade than there will be in the other three examples on that sheet.

The relative amount is minor in terms of the total cost.

So that essentially you can start at the subgrade and come up in comparing your costs of your pavements. You can start above the subgrade in making your comparison of comparative costs basically. And all of our cost figures start at the subgrade that we furnished.

They go above—in other words, they don't include the cost of the subgrade. They include everything above, as I understand it.

Mr. HARDY. Your subgrade, then, as you were indicating awhile ago—your subgrade cost is about the same for either; is that right?

General WILSON. It tends to be a little more under the other, but not enough to throw the weight off balance.

Mr. HARDY. Well, to return for just a second to this question of not having proven up the top course on your flexible pavement——

General WILSON. Yes, sir.

Mr. HARDY. Did I understand that projecting possible future requirements for heavy loads, you indicated that the rigid construction has a better chance of withstanding an overload than does your flexible construction?

General WILSON. I indicated or tried to indicate that if you designed the two pavements to carry the same load and everything was done perfectly and the future developed different kind of wheels or different tire pressures or different loadings, there was in my opinion more probability of the rigid doing the job longer. Whether it would last 20 years, there is no way of telling. But I think there is a greater probability of it accepting these changed things than in the other one. They would both carry them.

Mr. HARDY. They would both carry them.

General WILSON. They would both carry them, to a certain point.

Mr. HARDY. For which they were designed?

General WILSON. Yes, sir.

Mr. HARDY. But beyond that.

General WILSON. Beyond that, they will both carry them a certain way, depending on how much we have been able to guess, and how accurate we were in our empirical data and the factors of safety and so on.

But I would without question state that there is more chance of the rigid serving longer under the——

Mr. HARDY. For an overload.

General WILSON. For an overload.

Mr. HARDY. Now, just one other question.

In view of the fact that you have indicated that a design for rigid paving has been proven out with respect to the B–52, can you fix that approximately timewise, as to when you did have definite evidence that you had that problem licked?

General WILSON. Well, I would rather not give you—we had little doubt, I will put it that way, from the moment we knew about the B–52, and knew about the channelized traffic, but what we could project the curves and that they would work for the rigid.

But as to when we felt sure of it, I would rather ask one of these other gentlemen to answer it directly. But it is fairly recent. Can you answer that question, Mr. Zachrison?

Mr. ZACHRISON. We proof tested these requirements at both Waterways Experiment Station and at Ohio River Division Laboratory.

The Ohio River Division Laboratory conducted the investigation on the rigid and they proof tested it out right on the button as to what we had predicted.

Mr. HARDY. Can you tell us when that was?

Mr. ZACHRISON. Could you tell me that, Jim?

General WILSON. It is very recent.

Mr. SALE. Could I qualify your statement for just a moment?

General WILSON. Mr. Sale.

Mr. SALE. The actual loading of the B–52 in a concrete pavement duplicates the loading of a single wheeled B–36 we tested extensively back in 1944 and 1945.

The stresses that are induced in the pavement are essentially the same, and the thickness required to carry these loads are the same.

In 1955, and 1956 we determined for a 100,000 pound dual wheel loading what the additional requirements would be for the channelization factor, with the 100,000 pound loading. We found that our prediction of what was required checked out exactly in this test. We have already found out what was required by the old coverage criteria that existed prior to 1955 for a stress equivalent to the B–52.

Mr. HARDY. I think maybe we can button it down right quickly. The thing I had in mind was you didn't have the channelization problem until comparatively recently.

Mr. SALE. Yes.

General WILSON. That is correct.

Mr. HARDY. So you couldn't test for that until after you discovered what the problem was.

General WILSON. That is correct.

Mr. SALE. That is correct.

Mr. HARDY. I was trying to figure out as nearly as we could about when you did come up with a finding.

Mr. SALE. In June of 1956 we published a criteria which we figured was valid.

Mr. HÉBERT. Mr. Fisher.

Mr. FISHER. Just one more question.

You have said—and I join, too, in commending you gentlemen for a very, very lucid and very helpful presentation.

General WILSON. Thank you.

Mr. FISHER. You have said as of now you developed rigid——

General WILSON. Design criteria.

Mr. FISHER. Capable of taking care of any plane, as Mr. Hardy put it, that the Air Force has in use today.

General WILSON. Yes.

Mr. FISHER. You say you also have that for the flexible—you have a design for it, as of today. But the question of whether it would stand up for 20 years is more doubtful than the oth-

General WILSON. Well, for the B–52, sir, I don't say we have the design. I say we are satisfied that we have the design below the surface layer——

Mr. FISHER. Oh.

General WILSON. And we are fairly certain that we are on the track there. But I couldn't say that we have it.

Mr. FISHER. I see.

General WILSON. If we had to build one tomorrow, and for any reason it had be flexible, we would use what we have right now.

Mr. FISHER. I see.

General WILSON. And wouldn't be too concerned.

Mr. FISHER. You can't say categorically?

General WILSON. No, sir.

Mr. FISHER. Now that it would or would not prove out?

General WILSON. That is correct.

Mr. FISHER. Is that correct?

Geenral WILSON. That is correct, sir.

Mr. FISHER. It is to that point?

General WILSON. Yes, sir.

Mr. FISHER. It might or it might not?

General WILSON. Well, it very probably will.

Mr. FISHER. It very probably will, in the use of the asphalt concrete?

General WILSON. Yes, sir.

Mr. HÉBERT. Thank you very much, General.

The committee will recess now, until tomorrow morning, at 10 o'clock. The chairman also wishes to make a statement, that in event the House does not meet tomorrow, which it probably won't, that we shall also come back for an afternoon session, in order to try to catch up some lost time.

Thank you very much, General.

(Whereupon, at 12:10 p. m., the subcommittee adjourned, to reconvene at 10 a. m., of the following day, Friday, June 28, 1957.)

AIRSTRIP PAVING MATERIALS

FRIDAY, JUNE 28, 1957

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES, SUBCOMMITTEE FOR
SPECIAL INVESTIGATIONS,
Washington, D. C.

The subcommittee met at 10 a. m., Hon. F. Edward Hébert, chairman of the subcommittee, presiding, with the following members present: Mr. Hess, Mr. Gavin, Mr. Rivers, Mr. Cunningham, Mr. Fisher, Mr. Bates, Mr. Hardy, and Mr. Miller.

Mr. HÉBERT. The committee will be in order.

Mr. COURTNEY. Mr. Chairman, this morning we have the subject of the tests being made, about which the Chief of Engineers has testified, the tests being made, (1) with respect to rigid pavements, and the results and the current state of the art, and (2) the tests with respect to flexible pavement and the current state of the art so far as the laboratory technical studies are concerned.

General, will you identify yourself for the record, please, so that the audience may know who you are?

TESTIMONY OF BRIG. GEN. E. A. BROWN, JR., ASSISTANT CHIEF OF ENGINEERS FOR MILITARY CONSTRUCTION, DEPARTMENT OF THE ARMY, ACCOMPANIED BY R. L. HUTCHINSON, CHIEF, PAVEMENT DIVISION, OHIO RIVER DIVISION LABORATORIES; C. R. FOSTER, CHIEF, FLEXIBLE PAVEMENT BRANCH, WATERWAYS EXPERIMENT STATION; B. U. DUVALL, SPECIAL ASSISTANT TO DIRECTOR, OHIO RIVER DIVISION LABORATORIES, AND DR. W. J. TURNBULL, CHIEF, SOILS DIVISION, WATERWAYS EXPERIMENT STATION

General BROWN. Mr. Chairman, I am Brig. Gen. E. A. Brown, Jr., Assistant Chief of Engineers for Military Construction.

I am substituting for General Wilson, whom you excused from attendance at the session today.

With your permission, we propose to enter into phase 3 of our presentation as outlined by General Wilson.

I have with me Mr. R. L. Hutchinson, chief of the pavement division of the Ohio River Division Laboratories, who will discuss the rigid-pavement program and Mr. C. R. Foster, chief of the flexible pavement branch at the Waterways Experiment Station.

Also available, if the committee desires, and as requested by the committee, I have Mr. B. U. Duvall, special assistant to the director

of the Ohio River Division Laboratories, who is prepared to discuss, if you desire, the program on blast and spillage effects.

In addition, we have available this morning Dr. W. J. Turnbull, who is chief of the soils division at the Waterways Experiment Station.

He was requested, by name, by the committee.

Mr. COURTNEY. Mr. Chairman, may I interject right there? These gentleman—Mr. Duvall and Dr. Turnbull, especially—were asked for by the subcommittee, because their names and the results of their studies and their professional judgment has been found in a great deal of the literature dealing with this subject which is published in technical journals and the other scientific media.

Would you proceed, General? Let us take up first your subject of the rigid, which I believe will be handled by Mr. Hutchinson.

Will you proceed, Mr. Hutchinson, with your prepared statement?

Mr. HUTCHINSON. The first of my presentation is devoted to a summarization of work accomplished to date by the Rigid Pavement Laboratory. The task of the development of rigid-pavement design was assigned to the Rigid Pavement Laboratory, Cincinnati, Ohio, in 1941. Since that time valid and proved design criteria for plain rigid pavements and rigid overlay pavements have been developed and issued to the construction agencies for the following loadings and gear configurations.

1. 25,000-pound single wheel, which is the current light-load design for airfield pavement;
2. 100,000 pound twin wheel, which is the B–47 loading;
3. 240,000 pound twin-twin wheel, which is B–52 loading.

Valid and proved design criteria have also been developed for nonrigid-type overlay (asphaltic concrete and flexible pavement) over rigid pavement up to and including the B–47 loading.

The development of rigid-pavement design is accomplished by three primary investigational phases which are described briefly as follows:

(*a*) Small-scale-model tests: Small-scale-model slabs are constructed with known physical properties, fully instrumented to measure strains in the slab, placed on a known subgrade strength and subjected to various loads and gear configurations.

(*b*) Accelerated traffic tests: Full-scale test tracks are constructed and subjected to the actual loading and gear configuration of the aircraft. The test tracks incorporate such variables as pavement thickness, subgrade strengths, base courses, concrete materials, and joint designs. The test tracks are fully instrumented to measure strains in the concrete and deflections of the pavements under both static and rolling loads. To date some 11 such test tracks representing about 300 individual pavement sections have been constructed and tested.

(*c*) Condition surveys: Condition surveys which include pavement inspections and limited testing programs are conducted periodically at selected airfields through the United States. Condition surveys yield information regarding the performance of the pavements under actual aircraft usage and indicate the validity or necessary changes that may be required in the pavement-design criteria.

This investigation also yields information as to the durability of the pavement, the operational patterns of the aircraft and their effect on the pavement performance, and the adequacy of current construction techniques.

In addition to the development of design criteria for plain rigid, rigid overlays, and nonrigid overlays already presented, investigations are currently underway at the Rigid Pavement Laboratory to develop design criteria for reinforced rigid pavements, and prestressed rigid pavements.

To date, tentative design criteria have been established for reinforced rigid pavements for loads corresponding to the B–47 and B–52 aircraft. However, this design criteria must be validated. No firm design criteria for prestressed rigid pavement have been established as yet. Preliminary tests have been completed on a 4-inch prestressed rigid overlay on a 6-inch rigid pavement for loads comparable to the B–47 aircraft.

The second part of my presentation pertains to the proposed work at the Rigid Pavement Laboratory. The long-range program for the Rigid Pavement Laboratory is to develop design criteria for plain rigid pavement, rigid overlay pavements, and nonrigid overlay pavements for a 325,000 pound twin-tandem wheel load.

In addition pilot studies will be conducted to determine the feasibility of new methods of airfield pavement design.

Mr. COURTNEY. Mr. Hutchinson, can you tell the committee what the state of your technical information is with respect to surface conditions and problems if any to be expected on the surface of rigid pavement in use under B–47 loadings, and B–52 loadings?

Mr. HUTCHINSON. You are referring to surface defects?

Mr. COURTNEY. Surface defects.

Mr. HUTCHINSON. In the pavements?

Mr. COURTNEY. Yes, sir.

Mr. HUTCHINSON. We do have some spalling, that is, slight breakdown of the pavements at the joints in some cases. We have some surface defects due to the curing and the drying of the pavements. But these do not affect the structural ability or the load-carrying capacity of the pavements.

Mr. COURTNEY. So they are strictly a surface problem?

Mr. HUTCHINSON. Yes, sir.

Mr. COURTNEY. Is that right?

Mr. HUTCHINSON. Yes, sir.

Mr. COURTNEY. In the criteria which you have established as a result of your experimentation for the B–47 and ultimately for the B–52, I don't understand whether or not, from this statement, you have reached a firm position on criteria for the B–52 rigid slab.

Mr. HUTCHINSON. Yes, sir; we have. The 240,000-pound twin-twin wheel loading, which is the B–52 loading.

Mr. COURTNEY. You reached a design criteria for that?

Mr. HUTCHINSON. Yes, sir; that is correct.

Mr. COURTNEY. Does that involve a change in the mix?

Mr. HUTCHINSON. No, sir; the only change in mix that would be made would be to try to increase the physical properties—the strength of the pavement, and the durability of the pavement.

Mr. COURTNEY. Does it involve the use of reinforcing bars in any way?

Mr. HUTCHINSON. We have criteria for both plain concrete, without reinforcement, and as I said, tentative design criteria for pavement with reinforcing bars in them.

Mr. COURTNEY. But the reinforcing criteria, reinforced bar criteria, if you want to call it that, is still tentative?

Mr. HUTCHINSON. It is still tentative, and must be validated.

Mr. COURTNEY. And that involves, I presume, a change in design and volume, or mass of concrete?

Mr. HUTCHINSON. It will reduce the required thickness of the pavement, that is the required plain concrete thickness by the use of steel reinforcement.

Mr. COURTNEY. That is all with this witness, Mr. Chairman.

Now, Mr. Chairman, with respect to the flexible-type pavement, and criteria that have been set up for the loadings, first I think Mr. Foster will lead off on that.

Mr. FOSTER. The Flexible Pavement Laboratory has provided design criteria for flexible pavements for the same loadings mentioned by Mr. Hutchinson.

The general approach used by the Flexible Pavement Laboratory to produce design criteria for new aircraft or new conditions such as channelized traffic is to:

(*a*) Establish design criteria for the new condition by means of theoretical predictions and by engineering judgment.

(*b*) Check the predictions by means of accelerated traffic tests.

(*c*) Compare performance of pavements under actual traffic with design criteria and make adjustments to the design criteria where necessary.

The program includes studies to determine requirements for structural adequacy (thickness, compaction, and paving mixtures), for resistance to spillage and blast, and for smoothness. The later item has only been recently added to our program.

THICKNESS AND COMPACTION

When the study of channelization of B–47 aircraft showed that traffic was being applied at 5 to 6 times the rate of previous aircraft, the thickness and compaction requirements were increased by theoretical procedures to compensate for the additional repetitions. A test section has been constructed and trafficked with a simulated B–47 load to check these predictions. The results indicate the thickness requirements are slightly to moderately conservative and the compaction requirements are about right.

PAVING MIXTURE REQUIREMENTS

Very few cases of distress have occurred in the bituminous paving mixtures under actual airplane traffic but rutting of the bituminous paving mixture in the test at Kelly has focused attention on the problem of paving mix designs for channelized traffic. The Kelly test and two other tests conducted at Vicksburg are described briefly.

(*a*) Kelly: Kelly was a demonstration test. Adjoining sections of rigid and flexible pavement were designed for channelized traffic by the then current criteria. The subgrade at Kelly is a clay with a CBR of 5 and a K value of 70.

The flexible-pavement section was 52 inches thick consisting of 5 inches of pavement, 8 inches high-quality base, and 39 inches of subbase.

The rigid pavement was 20 inches thick.

Both pavements were subjected to accelerated traffic of simulated B–47 traffic.

The rigid pavement carried 30,000 coverages.

The flexible pavement rutted about 1½ inches deep by 9,000 coverages and traffic was discontinued.

Analysis of the test showed that the base, subbase and subgrade were intact and that all movement was within the asphaltic pavement. The instability of the mix was due to the fact that the mix contained too much asphalt for the traffic applied in these tests.

(*b*) Pavement design pilot section: Simultaneously with the Kelly test, a section was tested at Vicksburg with similar mixes but with a range of bitumen contents. Mixes placed at optimum bitumen content, the same as used at Kelly, also rutted but those placed with 20 percent less asphalt than optimum successfully carried 30,000 coverages of simulated B–47 loading. As a result of these tests and the tests at Kelly, interim recommendations have been made for reducing the bitumen content by 20 percent for channelized lanes for B–47 loading pending further study of other types of mixes and bitumens.

Additional study of the problem has shown that traffic during hot weather is significantly more detrimental in bituminous pavements than traffic during cold weather.

We have concluded that about 10,000 coverages of accelerated hot-weather traffic is probably sufficient for establishing design criteria for 30,000 coverages where the traffic is applied at all seasons of the year.

(*c*) Paving mixtures for very heavy loads: A pilot test section has been constructed at Vicksburg and is now being subjected to traffic. The Asphalt Institute has cooperated in this study and has designed the paving mixtures in certain items.

Traffic was started with a 325,000 pound load with 300 pounds per square inch tire pressures. The traffic showed that a definite problem exists for this load, and traffic was shifted to B–52 loading to obtain interim information on this load. Traffic is in progress at the present time, and has been carried to 11,000 coverages on certain items, and 6,000 on others.

These tests should provide a tentative mix design for B–52 traffic by further reduction in bitumen content over and above that used for the B–47. Reduction in bitumen content probably means some sacrifice in expected life and considerable experimentation with gradations other than those normally used by the corps and with special types of bitumens including those with high softening points is needed to develop mixes which will be satisfactory for B–52 traffic without reduction in bitumen content. Experimentation along this line is underway at the present time.

Summation:

STRUCTURAL ADEQUACY

Flexible pavements have been structurally adequate for light aircraft.

Distress has occurred under channelized B–47 traffic in flexible pavements in a significant number of cases. The distress has been attributed to overload, to construction deficiencies, and in two instances to deficiencies in the design criteria. The deficiencies in design criteria

were corrected in 1956 and increased emphasis has been placed on eliminating construction deficiencies.

The design criteria for B–47 loads, as currently revised, are considered adequate.

The design criteria for the B–52 loading are considered reasonably adequate for the lower layers (subgrade, subbase, and base) but these criteria need checking. The tentative design criteria for paving mixtures for B–52 loading which will be established as a result of the current testing may be safe from the standpoint of displacing under traffic but may result in pavements which are less permanent than those designed for nonchannelized areas. Considerable study is needed to develop paving mixtures which will carry B–52 traffic without the necessity for reductions in bitumen content.

With respect to future aircraft with very heavy loadings, 325,000 pounds, or twin tandems with 300 pounds per square inch tire pressures, design criteria can be produced for the subgrade, subbase, and base course but they will need checking.

Sufficient work has been done to show that paving mixtures for these loads present a problem. Research to date, however, does not show that paving mixtures for this load are impossible. Further investigation and testing is needed before any construction for this very heavy load is initiated.

Smoothness: Data are not available from the flexible paving investigations to support a statement.

Jet fuel spillage and blast: Rubberized tar pavements are fuel-resistant and have given reasonably satisfactory service. The effects of aging are not known.

LONG-RANGE PROGRAM

A long-range program to verify design criteria for B–52 loadings and to develop design criteria for a 325,000-pound load has been prepared and funds have been requested.

Mr. COURTNEY. Mr. Foster, I would like to direct your attention to the last part of your statement, with reference to the jet fuel spillage and blast, the so-called rubberized tire pavement. I take it that that involves some additives, such as the developments by United States Rubber, and Flintkote, and refers—or does it refer to the so-called critical areas where planes are warmed up and fueled?

Mr. FOSTER. The rubberized tar pavements have been developed as a substitute for portland cement concrete in critical areas.

Mr. COURTNEY. In those critical areas?

Mr. FOSTER. Yes, sir.

Mr. COURTNEY. So that portion of your statement deals primarily then with the condition that might be expected in the so-called critical areas?

Mr. FOSTER. Yes, sir.

Mr. COURTNEY. I take it you have not proved the length of service that might be expected of that quality or kind of a mix?

Mr. FOSTER. That is right.

Mr. COURTNEY. But aside from the factor of age, I take it you are satisfied that they will do the job?

Mr. FOSTER. We are satisfied that we have a spillage-resistant pavement that is reasonably adequate, and where the cost differential is

large enough it is something that should be considered in the overall program.

Mr. COURTNEY. Even on the critical areas?

Mr. FOSTER. Only on the critical areas.

Mr. HÉBERT. Everything has been made critical, so we are talking about everything.

Mr. FOSTER. This should be used only where spillage is a problem. That was primarily the apron and around fueling hydrants.

Mr. COURTNEY. You feel the state of that art is such that the material should be made competitive, is that it?

Mr. FOSTER. It is a reasonably satisfactory material. The using service, then—I mean that information has been presented to the using service, and the using service then makes up its mind whether it wants to accept a reasonably satisfactory material in lieu of a completely satisfactory material.

Mr. COURTNEY. But so far as technical information is concerned and so far as the proof developed in your laboratory is concerned with respect to the quality and kind of materials, outside of the factor of age or useful life, are you satisfied from the scientific point of view the material should be competitive?

Mr. FOSTER. May I say it this way?

We have studied the material.

We have worked with the producers to bring it up to a certain quality. The quality is now at the point where we are ready to propose its use. It has been used. We are still not satisfied with it. We are working for higher quality. But you can't wait until you get it exactly like you want it. So we have started using it in its present state. And we expect in its present state for it to give reasonably satisfactory service.

There have been a number of pavements built with this material. We are watching them constantly. And they are giving reasonably satisfactory service. It still needs to be improved. And the effects of aging are not known, because they are not very old.

Mr. RIVERS. Mr. Foster, a summary of your testimony is: from the experiments carried on by your department—and you are in charge of the flexible end of it?

Mr. FOSTER. That is right, sir.

Mr. RIVERS. That if you change the bituminous content—I think you call it bitumen?

Mr. FOSTER. Either word is satisfactory.

Mr. RIVERS. Yes. If you change the bituminous content, you have arrived at something which on its face, assuming that your sub-content is satisfactory and that you have licked that problem—you have arrived at something that appears to be satisfactory for the B–47 vintage of plane; is that correct?

Mr. FOSTER. That is correct.

Mr. RIVERS. Now, the overall distance of that satisfaction—are you prepared to say how long that possibly would last? Is it of indefinite duration or reasonable length of time?

Mr. FOSTER. Well, I don't think any pavement lasts indefinitely. But these pavements will last a comparable length of time to other pavements.

Mr. RIVERS. A comparable length of time to cement?

Mr. FOSTER. Well, to other bituminous pavements that are built by highway departments, and pavements which have been built by the corps for light-duty traffic.

Mr. RIVERS. I see.

You are not comparing it with rigid?

Mr. FOSTER. Well, I try to avoid the comparison with rigid because we try to produce a flexible pavement which will stand the traffic and be satisfactory, and in my work I try to avoid——

Mr. RIVERS. Of course, our thinking is not proscribed like that. Because we are authorizing the pavement for all of the freight.

Mr. FOSTER. That is right.

Mr. RIVERS. Now, let's get to the B–52: So far as the B–52 is concerned, your experimentations indicate that while you may be on the threshold, as General Wilson, I think, testified of developing something that would prove satisfactory for a B–52 vintage, or even the 325, to which you referred, or the 350, with the twin-twin tandems, or twin tandems, whatever it is, for channelized traffic, you are not prepared to state from your experimentation, are you?

Mr. FOSTER. That is right.

Mr. RIVERS. You don't know whether or not——

Mr. HÉBERT. What was your answer: "That is right"?

Mr. FOSTER. That is—I understand the question—that is right.

Mr. RIVERS. So far as the B–52 vintage or heavier is concerned, you are still working and you don't know whether you have gotten something that will last indefinitely or not?

Mr. FOSTER. Well, we are on the threshold. And as General Wilson said yesterday—If we had to for some reason produce a pavement, flexible pavement for B–52 loading, we would have a design which we would submit.

Mr. RIVERS. Do you find that the Asphalt Institute is carrying on experimentations on their own to justify consideration other than what you are doing?

Mr. FOSTER. The Asphalt Institute is carrying on laboratory investigations; yes, sir. They are cooperating with us.

Mr. RIVERS. They are cooperating with you.

Mr. FOSTER. Yes.

Mr. RIVERS. Do they carry on an intensive research?

Mr. FOSTER. I don't know how large the research is, sir.

Mr. RIVERS. Have you heard anybody say whether or not they carry on an intensive research?

Mr. HÉBERT. The Asphalt Institute, Mr. Rivers, will testify.

Mr. RIVERS. Just wait.

The Asphalt Institute is not testifying.

Mr. HÉBERT. They will. They can answer the question. This man can't answer the question; he doesn't know.

Mr. RIVERS. This man can tell me what he heard. We are not bound by the rulings of evidence, as our attorney will tell you, in congressional hearings. Now, we can pick up our information, so long as we don't offend the Supreme Court.

Now, I want to know if it is generally felt in your office that you are getting proper cooperation from the asphalt industry?

Mr. FOSTER. I think the Asphalt Institute, within the limits of their ability, are doing intensive research and have cooperated with us well.

Mr. RIVERS. So you feel, from what you have been able to ascertain, that you have gotten cooperation from them? I want the record to indicate that. Because I don't want it said to this committee or to the military that any industry expects the military to develop its product, you see?

Mr. FOSTER. I would like to say that, as far as I am concerned, the cooperation of the Asphalt Institute has been satisfactory.

Mr. RIVERS. That is satisfactory to me. I just wanted that for the record. I was interested to hear what you said in response to our distinguished attorney's inquiry, that you had found a rubber component that looked good on the critical area as we now understand it, that is the end and around the faucets where you pour the oil. So far as the wear and tear from the sun, the weather, and whatever other elements compose the disintegration components, you are not prepared to say, is that what you——

Mr. FOSTER. The rubberized tar pavements which are in service have given reasonably satisfactory service. I wouldn't say they are perfect, but they are sufficiently satisfactory that they should be considered in the overall picture, for the cost differential is quite high.

Mr. RIVERS. So far as the age from the weather and the sun and so forth, you don't know the durability of it?

Mr. FOSTER. That is right.

Mr. RIVERS. I think you made a fine statement.

Mr. CUNNINGHAM. Mr. Chairman, I would like to ask a question of this witness, and also direct the same question later to the previous witness.

Mr. Foster, if you have a son who is a pilot, or if you do not have a son who is a pilot, assuming that you did have a son who is a pilot, piloting military aircraft, would you be satisfied to have that pilot land on airstrips of flexible paving?

Mr. FOSTER. I have a son.

If he elects to be a pilot, if he can get an airstrip as good as an asphalt strip to land on, I will be happy.

He will have to land on a landing mat. He will have to land on surfaces worse than asphalt by far. So if he can get an asphalt strip to land on, I will be happy.

Mr. CUNNINGHAM. Would you be as well satisfied for him to land on an asphalt strip or a flexible strip as you would on rigid or cement?

Mr. FOSTER. If you might let me make it a little more personal, I fly quite a great deal and I have no qualms whatsoever on landing on an asphalt strip. There has never been, to my knowledge, a record of a landing plane falling through either an asphalt or a portland cement pavement. There have been taxiing planes that have fallen through both.

Mr. CUNNINGHAM. When they were landing?

Mr. FOSTER. No, taxiing.

Mr. CUNNINGHAM. What about the one at Offutt Air Force Base?

Mr. FOSTER. I am not familiar with Offutt. I heard it mentioned here a few days ago.

Mr. CUNNINGHAM. Now, Mr. Chairman, I would like to ask Mr. Hutchinson the same question. If you had a son who was a pilot or assume that you did, would you be satisfied to have him land on an airstrip of rigid or flexible pavement at all times?

Mr. HUTCHINSON. From my experience and inspection of airfield pavements, I feel confident that the rigid pavements are perfectly safe for a landing.

Mr. CUNNINGHAM. What would be your answer to the flexible?

Mr. HUTCHINSON. Again, I think I would have to voice Mr. Foster's statement there, that for the runway, from what I have seen of flexible pavement runways—I am not an authority on flexible paved runways. But I have all the confidence in the world that most of them I have seen would be safe to land on; that is, would not——

Mr. CUNNINGHAM. Do you know of any kind of pavement that you would rather have them land on, if you had a son or sons, than either flexible or rigid as we have it today? Is it possible to get a better pavement of any kind out of any other substance, such as steel or iron or stone?

Mr. HUTCHINSON. Well, I feel confident that better materials probably are available, but that the cost of these materials would be prohibitive for airfield pavements. That is, a steel deck or something like that would certainly probably be built stronger than either of the two. But the cost of the runway out of steel would be prohibitive.

Mr. CUNNINGHAM. Of course, the primary consideration of one member of this committee is the saving of lives.

Mr. HUTCHINSON. Yes, sir.

Mr. RIVERS. Let me ask Mr. Foster right there: You say you fly quite a bit and you have no qualms on landing on asphalt under all conditions. I imagine you said that. I assume you are talking about landing on them with a loaded B–52 under all conditions.

Mr. FOSTER. No, sir. I will fly in commercial aircraft where I can. I ride military when I have to. I assure you I have landed in commercial aircraft on fields which were as far underdesigned or as nearly underdesigned as those the B–52's are landing on.

Mr. CUNNINGHAM. Will the gentleman yield?

Mr. RIVERS. Yes.

Mr. CUNNINGHAM. I understood the answer to my question was you were dealing with military aircraft and not commercial. Am I wrong?

Mr. FOSTER. When I answered Mr. Rivers I said—at least when I answered you and said I fly quite a bit, I meant to, or should have said, I fly in commercial aircraft.

Mr. CUNNINGHAM. My question was propounded for military aircraft, a son or an assumption of a son who is flying military aircraft.

Mr. FOSTER. I asked permission to change the question to a personal one, and at that time I should have said I fly in commercial aircraft.

Mr. RIVERS. I didn't want the record to show that you had taken a B–52 and came down with all hands aboard, with all fuel aboard, under emergency conditions, and landed on a channelized construction. I just didn't want the record to have that in it.

Mr. HARDY. I would like, Mr. Foster, to concern myself a little bit with this question of spillage and paving that will resist it.

You used a term that I am not so sure I understood. You made a comparison between what is reasonably satisfactory and completely satisfactory.

Did I understand in response to a question I believe from—I don't know whether it was Mr. Hébert—that the only difference that you

place between these two terms is the lack of knowledge on the effect of aging?

Mr. FOSTER. If that was the connotation, it is not exactly right.

Mr. HARDY. I am not sure it was. That is what I wanted to clear up.

Mr. FOSTER. The performance to date has only been reasonably satisfactory. In addition to that, the effects of age are unknown.

Mr. HARDY. Now, what do you mean by "reasonably satisfactory"? It is a rather loose——

Mr. RIVERS. It is a relative term.

Mr. FOSTER. Well, maybe I could say this, that in engineering, no material or nothing is as good as you would like to have it. So the design is developed up to a state where you are willing to start using it. That is the best definition I can give you for this. This is sufficiently satisfactory that we think it should be used. You use it under those conditions, recognizing that some difficulties may be experienced in the use of it.

Mr. HARDY. Now, you have made a distinction between that and completely satisfactory. Then, do I understand that your rigid is completely satisfactory and you have no reservations at all about that?

Mr. FOSTER. Well, the rigid is completely satisfactory from the standpoint of fuel spillage.

Mr. HARDY. That is what I am talking about.

Mr. FOSTER. From the standpoint of fuel spillage, there is no damage to the rigid pavement by fuel spillage, to the rigid pavement itself.

Mr. HARDY. And at best any flexible paving that has been developed up to now does show some deterioration from spillage and has to be repaired?

Mr. FOSTER. The deterioration is not from spillage. It is from the characteristics of the material itself. It has more shrinkage than asphalt pavement and has cracks or will crack when it shrinks. The damage from spillage has not been determined, if there is any damage of spillage on this rubberized——

Mr. HARDY. It just isn't too satisfactory as a paving agent?

Mr. FOSTER. That is right.

Mr. HARDY. To return to your comments about design criteria and loading, you are a little more specific today than I believe that General Wilson indicated that you would be with respect to satisfaction of your paving mixtures for B–47 loading. I believe you indicate that in all respects flexible paving now is designed for adequate performance for B–47 loads?

Mr. MILLER. We feel that the design criteria for the B–47 loading is adequate.

Mr. HARDY. And your statement further indicates that with respect to the B–52, there is really no question about the adequacy of your subgrade and subbase and base, but you did put the further reservation in there to make some additional checking; is that correct?

Mr. MILLER. Well, I don't think that it is true to say that we have no reservations. We say they are reasonably adequate. They are based on predictions from the behavior under the B–47 traffic test.

We approach it similarly to the way Mr. Sale described yesterday, in that the extension to a new condition is predicted and then a test

is made to check that prediction. When we made the extension for the B–47, the checks worked out quite well. Therefore, we are confident of our prediction to the B–52's, but it needs checking.

Mr. HARDY. Do I understand you have run no tests with B–52 loadings?

Mr. MILLER. Not for the condition of subgrade, subbase and base.

Mr. HARDY. Well, you have for those factors on rigid—maybe I should ask Mr. Hutchinson.

Mr. HUTCHINSON. Beg your pardon? I didn't understand it.

Mr. HARDY. The question of subgrade, subbase and base—the base structure for the rigid paving has been proven out for the B–52's?

Mr. HUTCHINSON. We have never run any test with the gear configuration of the B–52. We have run tests with a gear that produces the same loading and stress in the pavement as a B–52. And under that loading, we have a subbase, or subgrade specification that will——

Mr. HARDY. I take it, Mr. Foster, you have not held similar tests on the base and subbase on the B–52 with respect to asphalt paving—they have not been run?

Mr. FOSTER. We have not run a test on flexible pavement for the subgrade, subbase and base with a B–52 loading, but we have made tests with other gears which make us confident of our predictions for this case.

So we feel they are reasonably adequate. But we also feel that they need checking.

Mr. HARDY. I wonder how experimentation and testing with respect to rigid have gotten ahead of experimentation and testing with respect to the flexible? Is it because of a lack of funds for research and development?

Mr. FOSTER. Well, no one thinks they have enough funds. We have worked with the Air Force on programs and up until the last year they have provided us with funds slightly in excess of our ability to hire people to use them.

I would like to qualify that by saying that had we determined several years ago that we wanted twice the effort, we could have hired up to that effort.

The reason that— the apparent reason or the reason for being ahead of rigid versus flexible is due to the fact that they have less layers to consider.

Mr. HARDY. The thing I am leading up to is to try to see what we can do to catch up.

Mr. FOSTER. We have submitted to the Air Force a requested budget for double the effort that we have in for the last 5 years. It is a 4-year program and it doubled the effort.

Mr. GAVIN. Would the gentleman yield?

Mr. HARDY. Just one second.

Do I understand you anticipate it would take 4 years to determine the adequacy with respect to flexible paving of B–52 loads?

Mr. FOSTER. No, sir, that covers the 325,000 pound load, also.

Mr. HARDY. I will be through in just 1 second, Mr. Gavin.

Could I get some idea of what your target date is with respect to proving out, either one or the other, of paving or a flexible design for the B–52 loading?

Mr. FOSTER. As a result of the tests which are under way at the present time, which should be completed this month, we should produce, if we are able to, and I think we will be, a tentative criteria for the B–52, that is for the paving mixture.

If we get that to the point where we can recommend it to the Chief of Engineers as reasonably adequate—that is the recommendation we have now for the lower layers—he will be in a position to consider whether or not he is ready to start recommending flexible pavement for B–52.

We still, then, will have to do approximately 1 to 2 years of checking to verify that tentative design criteria. At that time we will move into the 325,000 pound.

Mr. HARDY. Are you currently, then, running tests using comparable load similar to that which was done at the Kelly test?

Mr. FOSTER. The Kelly test was made with a B–47 load. We are currently testing with a load which simulates a B–52.

Mr. HARDY. That is what I mean. You are running a load test to simulate B–52?

Mr. FOSTER. That is right.

Mr. HARDY. At the present time?

Mr. FOSTER. Yes, sir.

Mr. HARDY. And you do expect by the end of this month you will come up with some sort of—did you say the end of this month?

Mr. FOSTER. I said the end of this month.

Mr. HARDY. Then within the next——

Mr. RIVERS. Week.

Mr. HARDY. No.

Mr. FOSTER. What?

Mr. MILLER. You mean June or July?

Mr. HÉBERT. This is June.

Mr. COURTNEY. 28th of June.

Mr. HARDY. That is what I am trying to get.

Mr. FOSTER. The tests are scheduled to be completed within the fiscal year, sir.

Mr. HARDY. Then you have only 2 or 3 more days.

Mr. RIVERS. The end of this week, I will say. Don't wait until midnight of Sunday.

Mr. FOSTER. It was earlier when I left home.

Mr. HARDY. That is what I was trying to establish.

Mr. HARDY. Then, within the next day or two, your testing will be advanced to a point where you expect to make a finding with respect to the adequacy of your design to handle B–52 loads?

Mr. FOSTER. We expect as a result of those tests to produce a tentative design criteria, which the Chief of Engineers will evaluate and determine whether or not he is ready to recommend for the pavement for the B–52.

Mr. RIVERS. Will the gentleman yield at this point?

Mr. HARDY. Just 1 second.

Mr. FOSTER. May I add one word to it?

Mr. HARDY. Yes.

Mr. FOSTER. I am giving you an erroneous impression if you think we can complete the test Friday afternoon, which is this afternoon, and have the results Monday morning——

Mr. GAVIN. With a definite answer.

Mr. FOSTER. To the Chief's office. It will be this summer.

Mr. HARDY. I was just going by your testimony, because I thought you said this month.

But you will have all of your data in and it will be a matter of evaluating it, I take it, after——

Mr. FOSTER. We will have to collect our data. We will hold a meeting of our board of consultants. The data will be presented to the board with our recommendations. The board will either concur or ask for something else. If it concurs in the recommendation, it goes to the Chief of Engineers. That will take about a month or a month and a half.

Mr. HARDY. Mr. Hutchinson, just a second. When you completed your design recomendations with respect to the rigid pavement, do you still have any tentative findings in there or are you pretty well satisfied with your conclusions?

Mr. HUTCHINSON. As far as an investigation similar to the one we perform at the laboratory, we do not have any tentativeness in the design criteria.

Mr. HARDY. You can come up with more positive conclusions than Mr. Foster?

Mr. HUTCHINSON. Yes, sir. As for our investigation, it is firm and valid. Now, of course, the proof of the pudding is after it is used with aircraft for a number of years.

Mr. HARDY. Now, just one more question. You say you have asked Mr. Foster for a substantial increase in your budget for continuing your experimentation in your research?

Mr. GAVIN. At that point, will the gentleman yield? That is the point I was trying to call to your attention, that yesterday General Wilson, I believe, indicated that they had requested from the Department of the Air Force an allocation of $500,000 for rigid and $800,000 for flexible for 1957–58. So the flexible is being given just as much consideration as the rigid.

Mr. HARDY. If the gentleman will just—I want to develop a particular point. I don't think it will conflict with the gentleman's idea. The thing that I wanted to find out—I recall General Wilson's testimony. How much of that will be under your control, or how much of it might go into other areas of experimentation, I don't know. But, thinking in terms of your own budget and what you asked for experimentation under your direction, you have requested, I believe you said, about double?

Mr. FOSTER. Double effort.

Mr. HARDY. About double the effort. Now, if you get that, you think you can prove out your 325,000-pound load in a 4-year period; is that right?

Mr. FOSTER. We can either prove it or disprove it.

Mr. HARDY. One way or the other. You can get a conclusion with respect to it?

Mr. FOSTER. Yes.

Mr. HARDY. Unless you do get that amount, you don't anticipate, or do you anticipate, that you could still prove it and arrive at a conclusion?

Mr. FOSTER. No.

Mr. HARDY. It will take you a longer period of time; is that your answer?

Mr. FOSTER. Well, we sat down and determined what we thought was necessary to prove or disprove it, and prepared a program. The program can be accomplished in any period of time. We recommended a 4-year program as being double our effort, which we felt was all that we could possibly hire up and undertake. Engineers are difficult to get. We have qualms of being able to do a double effort. But we were willing to try.

Mr. HARDY. So, even with the additional money, unless you can get the manpower you still won't be able to carry it on?

Mr. FOSTER. Yes.

Mr. HARDY. And it is your judgment, then, that, with this additional money, assuming you can get the additional manpower, the best you can presently hope for is about a 4-year program?

Mr. FOSTER. That is for the 325,000-pound load; yes, sir.

Mr. HARDY. Thank you, Mr. Chairman. That is all.

Mr. HÉBERT. Mr. Gavin, do you have a question?

Mr. GAVIN. The only thought I had in mind was that this formula that you are developing now in your experiments may not be the answer. You are not definite about that. It is a step in the right direction. And I suppose further experimentation after you do determine this formula for flexible, that it would be improving the situation, that it may not be wholly the answer, but it will be as good, in your estimation, as rigid; is that right?

Mr. FOSTER. In our estimation, the design that we will produce for the B–52——

Mr. GAVIN. Yes.

Mr. FOSTER. Will be satisfactory for the conditions it will be used for.

Mr. GAVIN. Under present conditions today?

Mr. FOSTER. Yes.

Mr. GAVIN. The increase in size or the load or something else that may change the complexion, too.

Mr. FOSTER. That is an entirely different thing. There will probably be some lack of permanence in the wearing surface, and the program that we have submitted includes a study of the other formulas, other bitumens, even, to rectify that lack of permanence.

Mr. GAVIN. Well, they are trying to point this situation here, that you should come up with a definite assurance that the formula you are going to recommend is the answer. That just isn't quite true, even though you are in a position—you think it is going to meet the situation, but you are just not assured that it is the answer.

Mr. FOSTER. We think it will meet the situation.

Mr. GAVIN. That is right.

Mr. FOSTER. Except for the possible lack of permanence.

Mr. GAVIN. Under the circumstances at present?

Mr. FOSTER. That is right.

Mr. RIVERS. Will the gentleman from Pennsylvania yield right there?

Mr. GAVIN. Yes, I will be glad to.

Mr. RIVERS. Mr. Chairman, I just want to ask him this question: That recommendation, in response to Mr. Hardy's and Mr. Gavin's

inquiry, that you are going to make to the Chief will be for the base, the subbase, and the bitumen content—the three things?

Mr. FOSTER. The pavement, yes.

Mr. RIVERS. The whole business?

Mr. FOSTER. Yes.

Mr. FISHER. One question, Mr. Chairman. Mr. Foster, assuming that adequate funds are provided for this continuation of your research and experiment, can you make any kind of an estimate as to how long it will be before you are able to arrive at pretty definite conclusions about the asphalt concrete and its capability in taking these heavy aircraft? You are right in the middle of it now; aren't you?

Mr. FOSTER. We estimate that this summer we will make tentative recommendations to the Chief of Engineers regarding the paving mixture for the B–52, which is the last item that we are holding back on. We realize at the present time that that paving mixture will have less permanence than desired. We have in the program experimentation with other types of formulas and other types of bitumens to rectify that lack of permanence, and my estimate is that that is a 2-year job.

Mr. FISHER. That is the bitumen content and so forth in regard to the mixture?

Mr. FOSTER. The design which we expect to produce this summer will be a further reduction of bitumen content with standard mixes. We expect that, by using other types of bitumens or possibly other types of aggregates, we can have a mix which will stand up under B–52 loading without that reduction in bitumen content.

Mr. FISHER. You anticipate that you may be able to do that?

Mr. FOSTER. Well, as a possibility, and we should investigate it.

Mr. FISHER. I see.

Mr. FOSTER. And that is the item that I think will take about 2 years to investigate.

Mr. HARDY. Mr. Chairman, did we have any testimony concerning the status of determination of criteria, design criteria, for rigid pavements to accommodate the 325,000-pound load?

Mr. HÉBERT. I don't think so. My recollection is that is also an experimental stage. The only positive conclusion they have on the rigid is the use of the B–52.

Mr. RIVERS. That is 250.

Mr. HÉBERT. That is 250.

Mr. HARDY. If that is the case, I would just like to ask Mr. Hutchinson the status of that program and when he expects to come up with a finding on the 325,000 load.

Mr. HUTCHINSON. Sir, we have just awarded a contract for construction of a test track, to be tested with the 325,000 twin tandem loading. That track will be constructed this summer and will be traffic-tested next spring, possibly, and completed by the end of fiscal year 1958.

At that time we will have either proved or disproved, I should say, the rigid pavement design criteria, plain concrete design criteria, for the 325,000 twin tandem wheel.

Mr. HARDY. Then the experimentation and research in connection with rigid paving lends itself to a little speedier determination than it does with flexible; is that right? That is a correct statement?

Mr. HUTCHINSON. Well, as Mr. Foster explained, we do deal with less layers of material.

Mr. HARDY. Well——

Mr. HUTCHINSON. I think——

Mr. HARDY. I gather you expect to arrive at a conclusion ahead of Mr. Foster.

Mr. HUTCHINSON. Well, we expect to arrive at a conclusion for plain concrete at the end of 1958, 1 year from now.

Mr. RIVERS. All he has to do is make his a little thicker?

Mr. HUTCHINSON. That is correct.

Mr. HARDY. That is all.

Mr. HÉBERT. There is one point I want to have clear. The testimony given this morning is on the competency of both the rigid and the flexible paving. However, there is no indication that after the conclusions have been reached the using service would adopt what your conclusions are. I am particularly referring to Mr. Foster's testimony on flexible.

In other words, you expect to come up with an answer in a short period of time as related to the usability of the flexible paving. However, you merely pass that information on after it is evaluated by the chief—you pass that evaluation on to the using service and there is no compulsion on the part of the using service to utilize your findings?

General BROWN. May I make a comment, Mr. Hébert.

Mr. HÉBERT. Yes.

General BROWN. There is a possibility, as General Wilson indicated yesterday, that we might, in the chief's office, ask for more testing on that, since it is strictly——

Mr. HÉBERT. I mean after the conclusion is reached——

General BROWN. If we decide to send it to the Air Force, then it is their decision.

Mr. HÉBERT. To make use of it. The crux of this whole hearing is to find out, of course, whether the comparable flexible usage is compulsive on the part of the using agency. I just want it clear that although you do come up with two products of equal desirability or equal capability, there is nothing to compel the Air Force to use it. You could come up with a better product for flexible and the Air Force could still say, "We insist on concrete."

General BROWN. That is correct.

Mr. BATES. Mr. Chairman, have we had any information on the general availability of concrete on the consumer market today?

Mr. COURTNEY. No.

Mr. BATES. What is the situation as far as the availability of concrete outside the military? Of course, they are going to get what they need. But for commercial purposes today?

Mr. HUTCHINSON. Mr. Bates, I don't feel I am qualified to answer that question because I just do not know. Insofar as I know, the military has been able to acquire all that it needs.

Mr. BATES. I am sure that the military has.

Mr. HUTCHINSON. That is about the limit of my——

Mr. BATES. But a few months ago I had a constituent of mine call me up and he couldn't get some concrete and wanted me to get it for him. You have no information on the commercial market today?

Mr. HUTCHINSON. No, sir, I do not.

Mr. HÉBERT. Mr. Courtney, any further questions?

Mr. COURTNEY. I have a few questions with respect to the Kelly test, Mr. Foster.

I notice in your prepared statement you call the Kelly test a demonstration test. Now, I will ask you whether or not the criteria employed in the Kelly test— the design employed in the Kelly test—is the same design that you are employing now to test the B–52 loading?

Mr. FOSTER. No, the word "demonstration" implies that it was a demonstration of pavements designed by the then current design criteria.

The Kelly test was designed, or the sections of Kelly were designed exactly as a district office would have designed a pavement for that condition.

Mr. BATES. A district office of what?

Mr. FOSTER. Of the Corps of Engineers.

Mr. BATES. Of the Corps of Engineers?

Mr. FOSTER. Yes.

Mr. BATES. But it is not the same design that you have been discussing here used in your experimentation?

Mr. FOSTER. In our experimentations we design some sections understrength, some overstrength, and some which we think are right, so that we can get some failures and some satisfactory pavements. But Kelly was designed to be what the then current criteria called for.

Mr. BATES. Well, my question, then, gets down to this: Is there any comparability between what was tested at Kelly and what you were testing at Vicksburg?

Mr. FOSTER. You mean today?

Mr. BATES. Yes, sir.

Mr. FOSTER. The mixes which are in place at Vicksburg today have been designed taking into consideration the distress that occurred at Kelly, and they are different; yes, sir.

Mr. BATES. They are different?

Mr. FOSTER. Yes, sir. Had we built pavement today—that is if a district office builds a pavement today for channelized traffic of a B–47, it would be built different than Kelly was built because we have changed the criteria as a result of the Kelly test and those at Vicksburg, also.

Mr. BATES. And those at Vicksburg as well?

Mr. FOSTER. Yes, sir.

Mr. BATES. Then, so far as a contribution to the present understanding of the problem, the Kelly test would have little validity in your opinion, would it not?

Mr. FOSTER. The Kelly test taught us an awful lot about channelized traffic, but as to the problem of whether or not asphalt can stand the traffic, it has little validity.

Mr. BATES. Little validity.

Mr. FOSTER. Yes.

Mr. RIVERS. Concerning Vicksburg, Mr. Chairman, I would like to ask Mr. Foster—I know it is a very large installation. How much would you say the Army engineers has invested at Vicksburg? I know they can duplicate a whole harbor in one of their facilities. But I have never seen Vicksburg, but I heard a lot about it.

Mr. FOSTER. I don't know what the investment is, sir.

Mr. RIVERS. What about that, General? Isn't that one of the largest installations?

General BROWN. It has been in existence for a considerable period of time, but I would have to get you those figures, Mr. Rivers. I don't know what the current investment is.

Mr. RIVERS. I know they have duplicated a harbor at my home town.

General BROWN. That is correct, sir.

Mr. RIVERS. The whole business.

General BROWN. That is right, sir.

Mr. HÉBERT. Mr. Courtney, any further questions?

Mr. COURTNEY. One question further, Mr. Chairman.

In the present state of the art, Mr. Foster, in the present state of your experimentation, so far as scientific information is concerned and technical experimentation is concerned, what is your opinion as to whether or not, in view of the progress you have made and detailed, this, considering cost, is an appropriate time on which to freeze on one design criteria or one kind of material?

Mr. FOSTER. You are asking me a question that is actually a little out of my field, but——

Mr. COURTNEY. I am only asking you with relation to scientific information such as is within your knowledge as a technician. I am not talking about the military considerations or anything of that kind.

Mr. FOSTER. If I were in the position of having to make a decision, I can only make a decision to utilize portland cement concrete for B–52 loading.

Mr. COURTNEY. At the present time?

Mr. FOSTER. At the present time. For any loading less than that, it should be competitive.

Mr. COURTNEY. But in the present state of the art, are you prepared to say that that should be an inflexible, or rather a permanently established criteria?

Mr. FOSTER. That should be a criteria which exists only until——

Mr. COURTNEY. Until such time as you come up with a——

Mr. FOSTER. With a recommendation.

Mr. COURTNEY. With a recommendation or an answer——

Mr. FOSTER. And it is accepted by the Chief of Engineers.

Mr. COURTNEY. I see.

Mr. HARDY. I just want to inquire about this Kelly test. As I understand the testimony we have had, there was no breakdown except with respect to the top layer of the asphalt paving. Did you examine that test and concur in that finding?

Mr. FOSTER. I will say this: I was responsible for that finding, yes, sir. The only distress was in the asphalt-paving mixture.

Mr. HARDY. Are you familiar with the repair that was made on that surface?

Mr. FOSTER. Since yesterday I became familiar with it.

Mr. HARDY. Well, do I understand, then, that you did not participate in any recommendations for resurfacing of it?

Mr. FOSTER. The test was under our supervision, and it was our responsibility to have it repaired after we were through. The repair was done, or was accomplished by the engineer at the base, under

our direction. It was a minor thing, and that is why I didn't know about it yesterday. Since then I found out about it.

Mr. HARDY. It was a minor thing. What do you mean by that?

Mr. FOSTER. It consisted only of taking out a 12-foot strip where the traffic had been applied to a depth of an inch and a half and replacing it with asphalt concrete similar to that as used on other areas of the base.

Mr. HARDY. You don't mean by that that the damage was limited to a 12-foot strip?

Mr. FOSTER. Yes, sir.

Mr. HARDY. How long a strip of asphalt paving was it?

Mr. FOSTER. Well, the traffic was carried on over 200 feet of the taxiway, that area 12 feet wide.

Mr. HARDY. In an area 12 feet wide.

Mr. FOSTER. On a strip 200 feet long.

Mr. HARDY. So you had to replace a 12-foot-wide strip for the entire distance?

Mr. FOSTER. Of 200 feet.

Mr. HARDY. Of 200 feet.

Now, did you replace it with the same kind of paving, asphalt paving, that was used elsewhere on the base or did you replace it with a new mixture?

Mr. FOSTER. It was replaced with the same type of pavement that was used elsewhere on the base.

Mr. HARDY. That was different from what had been used on the test strip.

Mr. FOSTER. Slightly different, yes, sir. The taxiway that this was placed on was a latter taxiway and gets relatively infrequent traffic. The test section was designed for channelized traffic, so the mixes have to be slightly different.

Mr. HARDY. Then does that mean that the mix that is currently used on there was inferior to that which was used for the test track?

Mr. FOSTER. No; it is not inferior. It is better suited to the traffic that it will get than the mix which was in the test track.

Mr. HARDY. Do I understand that that section of the taxiway is not involved in any channelized use at the present time?

Mr. FOSTER. That is right.

Mr. HARDY. That has only infrequent traffic?

Mr. FOSTER. That is right.

Mr. HARDY. Does that have any use by any aircraft heavier than the B–47, or do you know?

Mr. FOSTER. I do not know that.

Mr. HARDY. That is all. Thank you.

Mr. BATES. How long did it take you to make those repairs?

Mr. FOSTER. I don't know. I think it was in the order of 2 or 3 days. It was a very small job.

Mr. BATES. Then, if you had used that for a regular taxiway, under regular circumstances, how long do you think it would have lasted? How long that taxiway would have lasted under normal use, do you think?

Mr. FOSTER. The repairs were made last year. It is in good shape at the present time.

Mr. BATES. If it hadn't been an experiment, how long do you think it would have lasted under normal use?

Mr. FOSTER. If it had not been an experiment? The latter taxiway would have lasted for the design life, which was, on—we talk about 20 to 25 years.

The latter taxiway gets relatively infrequent traffic.

Mr. BATES. You would have had to repair it before that time had expired? But until the next repair, how much time would have transpired?

Mr. FOSTER. I am sorry, Mr. Bates, I don't quite——

Mr. BATES. What I am trying to get at is the question of tying up operations. If you had used this for operational purposes instead of a test, and you would use that kind of material, how much time would have been lost for operations had it been used for regular purposes instead of merely for a test?

Mr. FOSTER. Had it been used for operational purposes and being on a latter taxiway, it would not, in my opinion, be subjected to any stress within its design life. Had it been on a primary taxiway, I still do not think that it would have suffered severe distress in the design life. The channelized traffic duplicates several years' operation in a short time. Had it suffered distress, it would have been up after 5 or 6 years of its life. The repairs would have been—would have taken longer because it would have been a longer strip, but it would have been in the order of a 2- or 3-week job to repair it.

Mr. BATES. That is what I was trying to get at originally, a couple of days ago. One was on the question of the cost differential and secondly how much it would tie up operations. So you don't think it would have been a serious problem as far as operations are concerned?

Mr. FOSTER. Well, whether 2 or 3 is serious or not, I can't answer. Two or three weeks may be serious to the Air Force and I can't answer that.

Mr. FISHER. Mr. Foster, you certainly made a fine witness and have given us a lot of information. Based upon all of your experience and these various tests that have been made, would you say that you are optimistic about the cost effects of coming up with a flexible form of paving that will meet the needs of a modern heavy-type aircraft? Is that your feeling in the back of your mind, that you are optimistic, that you are on the right track and it may prove out?

Mr. FOSTER. Maybe I have taken that attitude and maybe if I could say what I think—I think no one ever really knows. I am intrigued with a difficult task and that is my optimism. I think there is sufficient possibility to warrant the expenditure of funds, and I would be happy to do the research if it is determined it will be done.

Mr. RIVERS. And it would be well within the competitive range?

Mr. FOSTER. Yes.

Mr. HÉBERT. Well, thank you, gentlemen, very much. On behalf of the committee the Chair wishes to compliment the Corps of Engineers on the splendid presentation which it has made, and I hope, General Brown, you will convey those sentiments to General Wilson and also to General Itschner.

General BROWN. Thank you very much.

Mr. HÉBERT. We are very, very well pleased with the presentation of the Corps of Engineers, the competency of their witnesses and their cooperation.

The next witness, Mr. Courtney.

Mr. COURTNEY. The Asphalt Institute, Mr. Chairman, I think is in order next.

Mr. Chairman, may we have a slight recess?

Mr. HÉBERT. The committee will stand in recess for 5 minutes.

(Whereupon, a short recess was taken.)

Mr. HÉBERT. The committee will be in order.

I understand that Mr. Duvall had a prepared statement to give to the committee. So we will insert it in the record.

Mr. COURTNEY. Yes, Mr. Chairman, the plan was to insert it in the record. It relates to a subject which in the agenda of the committee has been settled and is not an issue in this hearing.

(The statement is as follows:)

HEAT AND BLAST EFFECTS ON AIRFIELD PAVEMENTS

The investigation of the potential effects of the heat and blast of jet aircraft on airfield pavements has been a continuing study since the inception of jet aircraft in the mid-1940's.

The objectives of these studies have been the solution of problems involved in design, construction materials, construction procedures, and the maintenance of existing and newly constructed pavements.

The procedures followed in an effort to attain the objectives, briefly stated, have been:

(*a*) Library studies have been made of existing general related information on materials which might be used economically. In the library-study category is also the use of Air Force guides on aircraft and propulsion units, conferences with Wright Air Development Center technical personnel to obtain data and general future planning information, and contacts with engine and aircraft manufacturers for the same purpose.

(*b*) Time-movement studies were made of aircraft operations at selected Air Force bases including static aircraft operations for maintenance purposes.

(*c*) In an effort to anticipate the effects on pavements, facilities have been constructed at the AFFTC, Edwards AFB, to determine the temperature rises induced in pavements during time operations to simulate normal operations of jet aircraft. Supplemental to this are pavement surface condition surveys at representative Air Force bases and the investigation of reported damage to airfield pavements due to heat and blast.

(*d*) The laboratory materials studies conducted have included the conventional portland cement concrete aggregates, formed refractories such as firebrick and tiles, and castable refractories used by both conventional and pneumatic ("gunited") placement.

(*e*) The results of the laboratory materials studies form the basis for materials and construction procedures to be utilized in field installations. These are made to substantiate, under airfield operational conditions, the findings of the laboratory investigations.

The results of the overall studies prior to mid-1954 indicated that with propulsion units then used and with the attitude of then operational aircraft, the heat and blast impinged on pavement surfaces was not of sufficient magnitude to affect the structural properties of portland cement concrete pavements. The average maximum pavement surface temperature measured up to that time was about 300° F. with one aircraft producing a surface temperature of 385°. It might be noted that the average maximum pavement surface temperature measured was the break point at which asphaltic concrete pavements begin to show minor surface erosion.

Information obtained also indicated that jet aircraft propulsion units were far from the ultimate as to the potential of such systems with respect to order of maximum temperature and blast velocity. The considered judgment of engineers was that critical areas of airfield pavements should be able to withstand temperatures above 1,000° F. with 2,000° being considered a probable maximum.

Consequently such studies were planned and initiated.

The studies conducted since mid-1954 have shown that under certain operational conditions pavement temperatures of 900° F. will develop with one aircraft, the F–100D.

This temperature is in excess of that for satisfactory performance of portland cement concrete subject to sustained or numerous repetitions of such operations. Consequently, a higher type construction material was required for critical areas of an airfield system. The development of a heat resistant or refractory pavement for these critical areas was then initiated.

These continuing studies have also shown that only certain aircraft are a potential source of damage to pavements. Others may be regarded as requiring no consideration as to pavement type regardless of the operations being conducted. No specific information has been obtained as to the potential effects of the vertical takeoff aircraft.

On the basis of the Rigid Pavement Laboratory studies, including field observations and discussions with United States Air Force operational personnel, it is the studied opinion that for current operational aircraft and those anticipated in the next 3 years:

(*a*) Where existing pavements are portland cement concrete, special heat-resistant pavements are not required for runway ends and taxiway approaches to runway ends, based on present knowledge; however, these areas should be subject to frequent inspections since repeated lower order thermal shock may gradually lower the quality of portland cement concrete pavements.

(*b*) Heat- and blast-resistant pavements will be required for:

1. Portions of aprons which will be used for maintaining jet aircraft and subjected to long periods of heat and blast incidental to complete checking of engine performance.

2. Areas of pavement subjected to power checks of jet aircraft prior to take-off, such as certain portions of warmup pads.

The Rigid Pavement Laboratory studies to date have shown that pavement surfaces of refractory materials resistant to jet aircraft exhaust heat and blast can be constructed. This work is subject to confirmation on a field test installation basis, for which plans and specifications have been completed.

Future studies of the problem of providing selected areas of an airfield system with pavements resistant to heat and blast of jet aircraft should take cognizance of the fact that ultimate temperatures to be considered as limited only by developments in the metal-alloy field.

Current developments in this field point to possible hotter engines and dependent on aircraft attitude, could mean higher pavement temperatures. Also, some of the developmental jet engines, such as the XJ–89 and XJ–91 by Allison division of General Motors and Pratt & Whitney, respectively, have thrust appreciably greater than any now in production or in the final development stage.

Mr. COURTNEY. Mr. Buchanan.

Mr. BUCHANAN. Yes, sir.

Mr. COURTNEY. Mr. Chairman, the Asphalt Institute is prepared to testify. We have Mr. J. E. Buchanan, its president, and Mr. Arvin S. Wellborn, its chief engineer.

Mr. Buchanan has a prepared statement, Mr. Chairman.

Mr. HÉBERT. Mr. Buchanan, you may proceed. And I will ask the cooperation of the members of the committee to allow you to finish your statement before asking questions.

TESTIMONY OF J. E. BUCHANAN, PRESIDENT, AND ARVIN WELLBORN, CHIEF ENGINEER, ASPHALT INSTITUTE

Mr. BUCHANAN. Mr. Chairman, and members of the subcommittee, my name has been announced, J. E. Buchanan, and I am president of the Asphalt Institute.

With me is Arvin S. Wellborn, who is chief engineer of the institute. Mr. Wellborn was present and testified at the hearings on airfield paving before a subcommittee of the House Armed Services Committee in February 1954.

Mr. Wellborn has maintained continuous contact with the airfield paving problem since the previous hearings, and is present today with engineering data to document the institute's statement.

If it may please the subcommittee he will present our documentation immediately following my brief statement. In case you desire it for reference, a brief summary of my own background is included as a footnote hereto.

(The summary is as follows:)

I am engineering graduate and a registered professional engineer. My initial experience with asphalt research, design, construction, and education started in 1927 and continued for some 15 years.

Then for nearly 4 years as a Reserve officer on active duty in the Corps of Engineers during World War II, I was principally concerned with military airfield problems, first at the Engineer School, Fort Belvoir, and then overseas in the India-Burma and China theaters. I have had over 20 years of Reserve and active duty in the Army and presently I am in the Retired Reserve. For 8 years after World War II I served as president of a State university, resigning voluntarily to join the institute in July, 1954.

The Asphalt Institute was pleased to receive an invitation to appear before this subcommittee and offer whatever assistance it can to the distinguished members who are earnestly endeavoring to judge criteria to be used for military airfield construction.

The institute shares the national concern that our Air Force should maintain a peak striking efficiency. It is our hope also that this hearing will develop the fact that this paramount concern may be realized without extravagance and without establishing a monopolistic paving situation.

In case you desire it for reference, I have included as a footnote to this page a brief statement about "The Asphalt Institute and the extent of asphalt production in this country."

I should comment so it will not be overlooked, that asphalt is one of the major construction material resources of this Nation.

(The summary is as follows:)

Asphalt is a constituent of most petroleums. It is recovered from petroleum in the refining processes and constitutes a major construction material resource of this Nation.

The Asphalt Institute is a nonprofit research and engineering organization voluntarily supported by the majority of producers of asphaltic materials. The institute is recognized the world over as the asphalt-industry spokesman and engineering authority serving both users and producers of asphaltic materials through programs of engineering research, field studies, and educational activities, including technical publications and grants to engineering colleges.

To carry out its work the institute maintains a headquarters office and laboratories with an engineering staff at the University of Maryland and some 25 engineering field offices throughout the United States.

The institute has nothing to do with, and has no responsibility for production, distribution, pricing, selling, and commercial aspects or trade practices pertaining to asphaltic materials.

According to the United States Bureau of Mines, annual production of asphaltic materials now amounts to about 117 million tons. About 70 percent of this production, that is, about 12 million tons, is used in paving of all kinds; about 20 percent is used in roofing; and about 10 percent in various industrial applications.

It is no happenstance, and certainly no fact to be ignored, that about four-fifths of all the paved roads and streets in this country are surfaced with asphalt. Similarly, according to the Civil Aeronautics Administration, 7 of the 10 most heavily traveled civilian airfields in the United States are largely paved with asphalt. Moreover, no objections have been made to asphalt pavement to serve the jet-powered civilian aircraft that are soon to be put in service.

Now, with specific reference to the military airfield pavement problem, I should like to make these points.

1. We are not contesting the critical areas as understood in the 1954 hearings.

2. We are much impressed by the lucid and forthright presentation on Thursday, June 27, 1957, of Maj. Gen. Walter K. Wilson, Jr., of the Corps of Engineers, and I should like to make the same comment with respect to Mr. Foster this morning.

General Wilson made it quite clear that the principal new airfield paving problems that have arisen with respect to heavy military aircraft since the 1954 hearings before this subcommittee, relate to increase in plane weights and channelized traffic, particularly the latter.

3. As we understand it, channelized traffic is peculiar to the operation of military bombers such as as B–47 and B–52. Also, we understand that channelized traffic is not characteristic of other military aircraft types such as trainer, fighter, and cargo planes. Nor is channelized traffic characteristic of civilian aircraft. Moreover, previous testimony showed that distress due to channelized traffic occurred on both rigid and flexible pavements.

Therefore, it would seem proper at this stage of our engineering knowledge concerning both types of pavements, to accept the suggestion by General Wilson of developing special designs for the relatively narrow strips or channels used by these tracking bombers along taxiway centerlines and at the ends of runways, especially in view of the larger future loads mentioned by General Wilson, and also mentioned again this morning, 305,000 pounds as compared with 240,000 for the B–52 and 100,000 for the B–47.

But certainly, the existence of channelized traffic cannot justify the extension of "critical areas" to include all the paving on a military airfield. To do so would ignore real economy that is possible by using asphalt.

Pictured there for you gentlemen, is a photo of the airfield at Limestone, Maine. Concrete is shown at the ends of the runways and the warmup areas, but that long stretch of runway is asphalt, which we think is an excellent example of combined use of materials to serve the military needs and at the same time accomplish economy.

4. It is our understanding that of the several flexible pavements cited by the Air Force on Thursday, June 27, 1957, as showing distress under channelized traffic, not one had actually been designed for the loads or channelized traffic imposed. Neither was there any claim of plane damage or personnel injury related to the alleged distress.

Moreover, Mr. Chairman, this is a most important point to be clarified for our industry and its relations with civilian airport officials.

Civilian aircraft do not move in channelized traffic patterns. Asphalt pavement is adequately and economically serving our busiest civilian airports and, for the public record, it should be made clear that the problem of channelization is peculiar to the military.

5. The Asphalt Institute believes that the conclusions and decisions of the subcommittee following the February 1954 hearings were basically sound and proper. With minor reservations, the institute is still in accord with those conclusions and decisions. The reservations we have pertain to the ideas that 1,000 feet at ends of runways and that all aprons should be regarded as so-called critical areas. I believe in this example, that is 1,000 feet of concrete at the end of the runway.

We think, for example, that 300 feet of concrete at ends of runways would be sufficient. Also, we feel that only certain parts of the aprons are critical areas; not the entire aprons. But in general, we go along with the criteria agreed upon as being sound by the subcommittee after the February 1954 hearings.

6. It is still a recognized fact (as Mr. Ferry's figures show as presented in June 24, 1957)—last Monday that in most cases the first cost of asphalt pavement is decidedly less than competing types designed for the same loads. Further, it is generally admitted that asphalt pavement costs no more to maintain, and no figures to the contrary have been presented in these hearings. In addition, as General Wilson testified, maintenance of asphalt pavement, when needed, is much more easily and quickly accomplished as is new pavement construction. These are most important military considerations.

7. Asphalt paved airfields in the United States are presently serving all kinds of military aircraft traffic from the lightest to the heaviest. Moreover, heavy bomber airfields in foreign areas and the north country also are paved with asphalt and are successfully serving our military needs. These facts fly in the face of published sweeping statements attributed to Maj. Gen. Lee B. Washbourne in 1956 before the 37th Annual Convention of the Associated General Contractors to the effect that concrete can take it and asphalt can't, a statement that has been widely publicized and quoted. We admit a problem in channelized strips, but we think that, too, can be solved economically.

8. Recent testimony by Air Force officials to the Congress suggests that the heavy bomber is facing obsolescence by development of missiles, the probable time of displacement of the heavy bomber being only a matter of a few years in the future.

If this be the trend, then we would suggest that the recognized economy of asphalt construction, wherever and whenever it can be used, looms even more important than heretofore.

9. The institute sees no justification for the action of the Air Force in their Installations Engineering Criteria Memorandum No. 56–34 (100.1.2) dated May 25, 1956:

(1) Selection of pavement types.

(*a*) Primary use pavement at all Air Force installations will normally be constructed of portland cement concrete.

(*b*) The term "primary use pavement" is defined as (1) all paved areas on which aircraft are regularly parked, serviced, maintained, or preflight checked; (2) all runways having adequate length, width, and approaches to permit sustained uses by combat or combat-support aircraft, and (3) taxiways connecting paved areas defined in (1) and (2) above, which, by redefining so-called critical areas, amounts to circumvention of the criteria previously acceptable to the subcommittee. By broad and sweeping interpretation of critical areas on military airfields, whether they carry light or heavy military aircraft, it has been possible for the Air Force to eliminate asphalt entirely from operational areas in favor of concrete, as, for example, at Grand Forks Air Force Base, N. Dak.; Geiger Air Force Base, Wash.; and Richards-Gabaur Air Base, Mo., to name but three.

10. The economy and versatility, i. e., the engineering adaptability, of asphalt pavements are well known throughout the world.

And economy was never more important than it is right now to us in the United States. Elimination of lower cost asphalt paving where

it can satisfactorily serve not only wastes tax money in itself, but also it eliminates competition. History amply shows that elimination of competition and creation of monopoly always results in higher costs. As you gentlemen well know, there is no substitute for competition in the market place.

Moreover, elimination of use of asphalt pavement denies military personnel necessary experience for wartime know-how.

11. Asphalt pavement builders more often than not are subcontractors on airfield construction projects. These asphalt paving specialists often come within the congressional definition of small business. Elimination of asphalt paving on airfields would take away a substantial volume of business for which they are prepared to compete.

These small businesses should not be made to suffer unnecessarily such loss of opportunity to bid for asphalt paving work in which they specialize. Moreover, they need to have continuous experience with military requirements to be in readiness for emergencies.

12. Contrary to our understanding of the conclusions and decisions from the February 1954 hearings, there have been examples of contract awards for airfield paving to higher concrete bidders where lower bids had been entered for the comparable and alternate asphalt pavement designs. This is not only contrary to the subcommittee's instruction, but also it is poor public policy and wasteful of tax money. We cite a recent bidding and award at Geiger Air Force Base, Spokane, Wash., as a case in point. Here the award was made to the higher concrete bid in preference to the lower asphalt paving bid, despite the fact the two pavements were designed for the same military aircraft, a situation in which the award clearly should have been predicated on the low bid.

And I might interpolate, else why bring out alternate designs.

In this case the differential was 7.2 percent of the bid for the asphalt design and represented a waste of some $169,000 of tax money. Also, the low bidder was deprived of work to which he was entitled.

13. Much criticism has been leveled at asphalt pavement as a result of a test at Kelly Air Force Base during the summer of 1956. We regard the Air Force requirements and decisions pertaining to the Kelly test as decidedly unrealistic and unfair, and we are prepared to document our position.

In plain language the simple fact is that the asphalt mix used on the small asphalt test section at Kelly Air Force Base was too rich in asphalt content for the conditions of the test. If I heard Mr. Foster correctly this morning, I believe he made, in substance, that statement.

Anyone who knows the rudiments of asphalt paving technology knows how an overrich mix will behave. That is what happened at Kelly Air Force Base. The pavement did not fracture or collapse or disintegrate. It shoved out of position.

I have here a section of the pavement from Kelly Air Force Base. This was cut from one of the distress sections, one of the narrow channels where the wheels moved. Members of the committee can see that it did not disintegrate, fly apart—it suffered some deformation, but it still was capable of carrying planes. It did not drop the wheels through into the substructure below.

Normal procedure under such circumstances would be to adjust the mix, making it leaner. The pity is that the overrich mix in the test

panel at Kelly Air Force Base was not immediately replaced with a more appropriate mix. This was suggested, but the Air Force was apparently not interested.

Evidently, the behavior of the overrich mix at Kelley was considered justification of the previously announced criteria change. However, the overrich material was subsequently removed and replaced with a regular paving mixture, and put back in regular service. Reports to us are that it is serving satisfactorily. Mr. Wellborn will have some more to say from an engineering standpoint with respect to Kelly.

14. It is to be expected that our opposition will bring to your attention instances of distress in asphalt pavements. And, of course, there are some cases. Those that have come to our attention have been investigated by our engineers as objectively and thoroughly as circumstances permitted. In most cases the observed asphalt pavement distress could easily be corrected by normal maintenance procedures, and I should say, and quickly, too. However, where the difficulty resulted from poor drainage, inferior base materials or improper construction methods, as was found at two airfields, obviously the corrective measures will have to go deeper than the asphalt pavement itself.

15. As to failures of concrete pavement on airfields, we naturally are not fully informed. Nevertheless, we are aware that concrete pavement also has its troubles; for example, at Lake Charles Air Force Base, La., as was reported in these hearings. At any rate a lot of concrete pavement on military airfields has been resurfaced and is being resurfaced with asphalt. We are sure this would not be done unless the existing concrete needed something to correct its deficiences or distress.

Before closing, it is pertinent to mention Dow Air Force Base at Bangor, Maine, which is being paved with concrete. We are reliably informed that cracking and distress are already evident in some of the concrete slabs even before being subjected to traffic. I mention this to show that occasional distress is not peculiar to one type of pavement only.

But the cost aspect of the Dow Air Force Base paving is even more interesting. When bids were first invited, Dow was to have been paved in part with concrete, and partly with asphalt pavement. This was in accordance with the paving policy agreed upon after the 1954 hearing. The initial bid for all paving items amounted to $2,920,241.

Then what happened? The heavy-duty asphalt paving items were struck from the design and the contract renegotiated. The upshot of it all was a new cost figure for paving Dow Air Force Base, amounting to $5,873,873. This represents an increase in paving cost of nearly $3 million, double the paving cost of the project in the original bidding. We would be interested in the justification for this action.

May I ad lib that this great increase in cost may be an example of what happens when competition is eliminated.

And from an engineering standpoint it is entirely possible that the choice of rigid concrete for soil and frost conditions at Bangor in northern Maine was not the logical pavement selection.

This is a lesson learned from airfield construction experience in the north country as was approvingly noted by Mr. Ferry with respect to Thule. Asphalt paving has other advantages, in addition to its well-known economy. There are special conditions where engineering

analysis calls for its use to meet climatic, soil and water conditions, not only the frost conditions of the north, but also difficult and changing soil conditions in temperature and hot climates.

In conclusion, the institute recommends to the subcommittee that the sound conclusions and decisions following the February 1954 hearings be reaffirmed, and that the interpretation of "critical areas," for which competition between asphalt and concrete is to be eliminated, shall be properly confined to what is actually needed to serve the peculiar and special needs of heavy military aircraft.

I want to add particularly channelization.

Now, I should like to ask Mr. Wellborn to summarize for you our documentation.

Mr. WELLBORN. Mr. Chairman and members of the subcommittee. My name is Arvin S. Wellborn and I am chief engineer of the Asphalt Institute——

Mr. COURTNEY. One minute.

Mr. HÉBERT. One minute, Mr. Wellborn, please. Before we continue with Mr. Wellborn, perhaps the members of the committee would like to ask Mr. Buchanan some questions.

I will first ask you one question there, Mr. Buchanan, in which you make the statement that the Air Force apparently was not concerned or interested in making immediate changes at Kelly. Were any people from the Asphalt Institute allowed to be present during the test at Kelly?

Mr. BUCHANAN. I believe Mr. Wellborn has personal knowledge of that.

We had an observer there at least part of the time.

Mr. WELLBORN. Yes, we were invited to have an observer present, but we had nothing to do with the design or construction methods.

Mr. HÉBERT. You had nothing at all to do with the design or construction methods?

Mr. WELLBORN. No, sir.

Mr. HÉBERT. When this first distress occurred, and apparently from the mix, the lean mix—have you any knowledge that this was called to the Air Force's attention?

Mr. WELLBORN. At the time of the failure, was it called to the Air Force's attention?

Mr. HÉBERT. Yes.

Mr. WELLBORN. That the mix was too rich?

Mr. HÉBERT. Yes.

Mr. WELLBORN. Yes, indeed, it was called.

Mr. HÉBERT. Who called it to the Air Force's attention?

Mr. WELLBORN. As I understand, in the reports which we have received, this was called to the attention of the Air Force by both our observer and by the Corps of Engineers.

Mr. HÉBERT. Do you know the officer to whom—the officer of the Air Force to whom attention was called?

Mr. WELLBORN. I understand it was Colonel Lutz.

Mr. HÉBERT. Colonel Lutz—L-u-t-z?

Mr. WELLBORN. Yes, sir.

Mr. HÉBERT. And what was his reaction?

Mr. WELLBORN. His reaction was negative.

Mr. HÉBERT. I mean negative to what extent?

Mr. WELLBORN. He wasn't interested.

Mr. HÉBERT. How is that?

Mr. WELLBORN. He was not interested.

Mr. HÉBERT. He merely shoved off the suggestion that the mix should be improved, that it was too lean?

Mr. WELLBORN. That is my understanding.

Mr. COURTNEY. Too rich.

Mr. HÉBERT. Too rich, and did not attempt at all to rectify the situation?

Mr. WELLBORN. That is my understanding.

Mr. HÉBERT. Mr. Courtney, I will ask that you have the Air Force have Colonel Lutz available for us.

Mr. COURTNEY. Yes, Mr. Chairman.

Mr. BATES. Now, Mr. Chairman, just on that point I may have misinterpreted Mr. Foster's remarks, but, in reference to the overrich mixture, I had presumed he referred to Kelly in its regular service and not for purposes of the test.

Mr. BUCHANAN. No. The test section, sir, is what we are talking about.

Mr. BATES. Yes, but when it was repaired it wasn't done with the same rich mixture.

Mr. BUCHANAN. That is correct.

Mr. BATES. And, of course, the need for it was different than it was for the test. I would like to have that just clarified.

Mr. COURTNEY. Mr. Foster——

Mr. BATES. Is Mr. Foster here?

Mr. COURTNEY. Mr. Foster is right here.

Mr. BATES. Would you——

Mr. FOSTER. Would you repeat the question, sir? I didn't realize you were talking to me.

Mr. BATES. The statement here:

> However, the overrich material—

talking about Kelly—

> was subsequently removed and replaced with a regular paving mixture and put back in regular service. Reports to us are that it is serving satisfactorily.

Now, as I understood your testimony, you didn't put back the same type of rich mixture because the use to which it would be put in routine operation there was different than what you had for test purposes?

Mr. FOSTER. That is correct.

Mr. BATES. But you agree that the mixture was overrich for testing purposes?

Mr. FOSTER. The mixture which was in the text section at Kelly was too rich for the traffic that was applied in that test.

Mr. BATES. But the reason why you put it back was different than that. The reason that you put it back at a different mixture, regular mixture, is that it was only for normal purposes?

Mr. FOSTER. That is right.

Mr. GAVIN. Who developed the formula for that original mix that was put on Kelly?

Mr. FOSTER. The flexible pavement laboratory, sir.

Mr. GAVIN. Yes. Where was your Asphalt Institute that time, if you, in your estimation or opinion—you criticize it now. At the time the formula was developed, did you have any knowledge of it, as to

what mix was going in, as to whether or not you thought it was adequate to meet the specification required there?

Mr. WELLBORN. Yes, sir; we had knowledge about it.

Mr. GAVIN. What did you do about it?

Mr. WELLBORN. We informed the Corps of Engineers that we didn't think it would work.

Mr. GAVIN. What did the Corps of Engineers say?

Mr. WELLBORN. They said they thought it would work under the circumstances.

Mr. GAVIN. Do you have any written correspondence to that effect?

Mr. WELLBORN. No, sir. This was by telephone.

Mr. HARDY. Mr. Chairman——

Mr. RIVERS. I would like to say this. If we could confine—we only have 10 minutes. Confine your remarks.

Mr. HARDY. Could I just clear up the point Mr. Bates raised?

Mr. RIVERS. Yes.

Mr. HARDY. I wanted to be sure. Mr. Bates pointed out it was not the same mix put back. As I understand it, there was no repair of that strip for test purposes and the repair was made only after the strip was put back into regular, normal use, rather than test use; is that correct?

Mr. BUCHANAN. That is my understanding.

Mr. HARDY. See if we can get verification from Mr. Foster.

Mr. FOSTER. That is correct.

Mr. BATES. That is the situation.

Mr. RIVERS. Let's keep the record straight. Have you finished, Mr. Bates?

Mr. BATES. Yes.

Mr. GAVIN. I just have one question—I mean one observation. You state here:

> It is our hope, also, that this hearing will develop the fact that this paramount concern may be realized without extravagance and without establishing a monopolistic paving situation.

That is kind of a heavy charge, I would say. Because, when you continue on, on page 3, you say:

> It is no happenstance, and certainly no fact to be ignored, that about four-fifths of all the paved roads and streets in the country are surfaced with asphalt. Similarly, according to the Civil Aeronautics Administration, 7 of the 10 most heavily traveled civilian airfields in the United States are largely paved with asphalt.

I would say if you get 7 out of the 10 and you get four-fifths on the paving, you are doing pretty well with yours. It looks like, to me, you got more of a monopoly than the cement organizations. What do you think?

Mr. BUCHANAN. Mr. Chairman, I would like to refer to the photograph there.

Mr. GAVIN. I am asking you a question now.

Mr. BUCHANAN. I am answering——

Mr. GAVIN. You're talking about it looks as though you are developing a monopolistic practice on rigid and flexible pavements. And you point out here where you got four-fifths of all the paved streets in the country and that you got 7 out of 10 airbases.

I presume you are getting a pretty fair share of the airbases—the civilian bases, 7 out of 10.

And I presume you are getting a pretty fair share of the airbase construction in the military.

I don't like the inference that this hearing is developing rather toward monopolistic practices, because your own statement proves that you are doing pretty well, and it isn't developing a monopolistic situation. And you are talking also on the economic situation.

I am interested in the human factors. I am interested in lives, too, along with the tax money that might be realized from the differential between flexible and rigid.

We are interested in that, too. But this hearing shouldn't try immediately to infer that it is purely—this rigid construction is developing into a monopolistic situation, because I personally don't think it is.

Mr. RIVERS. Are you going to answer?

Mr. BUCHANAN. May I answer, Mr. Chairman?

Mr. RIVERS. Yes, sir.

Mr. BUCHANAN. My point is this, that if asphalt with its known economy will adequately serve parts, and important parts, of military airfields, then it should not be excluded by criteria determinations because by so doing, if that were done, then there would be a tendency toward monopolistic use of only one material on military airfields.

Mr. GAVIN. Why don't you reserve your monopolistic inferences until such a time as we get through with these high-costing experiments? At least, it was indicated that $8 million has been spent in the last several years on trying to reach a solution to this problem.

Before you start to base your arguments on monopolistic practices, I should think you would wait. In fact, as far as I can see now, the Corps of Engineers and the Department of the Air Force say they have spent $8 million in experiments that they are now conducting to try to reach a solution that will permit the flexibility pavement to come into the picture.

Mr. RIVERS. I think, though—I would like the record to be straight, though. I think the witness did show—you will have to give the witness credit—or he stated in the face of a competitive bid he was ruled out and that it wasn't economical to have it ruled out. That was one of his contentions, whereas, in your statement——

Mr. BUCHANAN. Yes, sir.

Mr. RIVERS. I believe it was in the Northwest, somewhere——

Mr. BUCHANAN. Mr. Chairman, I might make this comment, too. If we might be permitted to finish our statement, which is in two parts—the second part by Mr. Wellborn—I believe some of the comments made by Mr. Gavin will be answered.

Mr. RIVERS. We are going to meet—Mr. Hébert has gone now to get permission for the subcommittee to sit at 2 o'clock. I think it is the desire of the group here to adjourn at 12. We have to be on the floor for a time. Has anyone any questions of Mr. Buchanan?

Mr. CUNNINGHAM. I have, but I would rather defer them, because we don't have time, Mr. Chairman.

Mr. RIVERS. You can be back at 2, Mr. Buchanan?

Mr. BUCHANAN. Yes, sir.

Mr. RIVERS. Mr. Hébert has asked that we adjourn at 12. He is going to get permission to sit at 2. I think I can state we will be back here at 2 o'clock. Mr. Courtney?

Mr. COURTNEY. That is my understanding.

Mr. RIVERS. That is my understanding, too. So the committee will stand in recess until 2 o'clock.

(At 11:58 a. m., the committee adjourned, to reconvene at 2 p. m. of the same day.)

AFTERNOON SESSION

The subcommittee reconvened at 2 p. m., Hon. F. Edward Hébert, chairman of the subcommittee, presiding with the following members present: Mr. Hess, Mr. Gavin, Mr. Rivers, Mr. Cunningham, and Mr. Miller.

Mr. HÉBERT. The committee will be in order. Mr. Courtney.

Mr. COURTNEY. Mr. Wellborn was about—I think you had concluded with the questions, Mr. Chairman.

Mr. HÉBERT. Yes. I wasn't here. Mr. Rivers was presiding and he told me so.

Mr. COURTNEY. Mr. Wellborn had just started his statement, Mr. Chairman.

Mr. HÉBERT. All right, Mr. Wellborn, continue.

Mr. WELLBORN. Mr. Chairman and members of the subcommittee, my name is Arvin S. Wellborn, and I am chief engineer of the Asphalt Institute. I appeared before most of the members of this subcommittee at a hearing on airfield pavements in February 1954 and I appreciate the opportunity to present information again to this group.

I am going to speak briefly and to the point with reference to the bound exhibit material which you gentlemen have before you. It covers a broad range of subjects pertinent to this hearing and I will touch only on the highlights which may assist you in evaluating the distinctive features of asphalt paving.

Mr. Chairman, I would appreciate the inclusion of these exhibits in the record.

Mr. HÉBERT. We will make them as part of the record.

Mr. FOGO. Yes, sir. Without reading that, he wanted to make that part of the record.

Mr. HÉBERT. Yes, without objection.

Mr. COURTNEY. Mr. Chairman, one reservation with reference to the record. It is impossible to reproduce at the Government Printing Office the photographs.

Mr. WELLBORN. Oh.

Mr. COURTNEY. So with that one reservation, since we can't reproduce them.

Mr. WELLBORN. I understand, Mr. Courtney.

(The exhibits above referred to are as follows:)

FACTS SHOW ASPHALT CAN TAKE IT

By National Bituminous Concrete Association, Inc.

JUNE 17, 1957.

This outline highlights the facts leading up to and including the banning of asphalt concrete from competitive military paving contracts beginning December 20, 1955.

Since then, overexpenditures, preferential use of one paving material and the alienation of the asphalt industry have been the result.

These developments, in the light of asphalt concrete's serviceability, durability, and economy at approximately half of the Air Force, Navy, and Marine Corps bases, are documented in a 150-page presentation, entitled "Facts Show Asphalt Can Take It."

It has been prepared with the hope that it will be of convenience to the Committee on Armed Services in becoming acquainted with difficult-to-obtain facts.

H. K. GRIFFITH,
Executive Director, NBCA, Inc., Washington, D. C.

Our Government is being subjected to excessive expenditures because of the Air Force's preference for luxury pavements of portland cement concrete.

They cost more but are no better than asphalt concrete pavements.

Since the Air Force kicked asphalt concrete off the field 1½ years ago (December 20, 1955) the taxpayers have been out $26 million (estimated).

At just 8 Air Force bases, an extra $6,830,081 was spent:

$2,964,401 extra at Dow Air Force Base, Maine, resulted from a change to portland cement concrete, after the asphalt concrete contract was awarded and the asphalt paving plant had already been set up.

$474,878 extra at Grand Forks Air Force Base, N. Dak., and $324,270 extra (estimated) at Alexandria Air Force Base, Alexandria, La., when portland cement concrete was substituted for an asphalt concrete contract.

$2,500,000 extra (estimated) at Sheppard Air Force Base, Tex., was spent because asphalt concrete competition was eliminated.

$130,000 extra (estimated) was spent at Davis Air Force Base, Okla., for the same reason.

$436,532 extra was spent because the Air Force changed its mind at 3 bases (George Air Force Base, Calif.; David-Monthan Air Force Base, Ariz.; and Geiger Air Force Base, Wash.), and withdrew asphalt competitive options.

It is now too late to save $2,630,000 at Sheppard and Davis Air Force Bases, even though this economy was called to the attention of the Air Force and the Corps of Engineers. The reason? Asphalt wasn't allowed to compete.

It has been conclusively established that asphalt concrete pavements are sound both from engineering and economy standpoints, by—

Congress who appropriates the money to pay for them, the
Air Force who uses them, and the
Contractors who build them.

Despite the Air Force's agreement with Congress to allow asphalt concrete competition on paving contracts, a single Air Force decree virtually eliminated this material on technical grounds. No valid engineering reasons were ever disclosed.

What has been the result? Overexpenditures, preferential use of one paving material, and the alienation of the asphalt industry which is vital to our defense and economy.

Summing up, here are some of the things in store for us under the Air Force's present one-material paving policy:

$28 million extra (estimated) will go into luxury pavements from now until 1960.

One material (portland cement concrete) will continue its complete hold on our military paving contracts.

Costs for all pavements will spiral.

Construction and repair time on Air Force pavements will be needlessly prolonged—since portland cement concrete requires an extended amount of building time.

Through future disuse, the asphalt industry will lose its military construction know-how. The result? In the event of an emergency, it won't be possible to build Air Force bases fast, as asphalt contractors did during World War II.

The exclusive use of portland cement concrete has shown itself responsible for overexpenditures.

Before this policy eliminated free competition, asphalt concrete's economy was conclusively established. The proof—asphalt concrete was awarded contracts for half of our military pavements, while conforming to the rigid specifications of the Corps of Engineers and Air Force installations engineers.

General Washbourne said at the 1954 hearings that: "* * * the price of all paving would go up," if asphalt concrete were eliminated. Yet he banned asphalt concrete less than 2 years after (January 20, 1956). Simply by extending the noncritical areas on military airfields, asphalt concrete's use was practically eliminated, by one Air Force decree. But on the record, its official paving policy remains unchanged.

The Air Force's reasons for banning asphalt are rather vague. The Air Force claims that its needs have not been properly met by this material, and cites complaints. Independent engineering investigations do not concur. These are examined on pages 8 to 13.

During the past 1½ years, the Air Force's paving policy has been full of contradictions. Asphalt has been banned from primary runways and taxiways.

The Air Force has damned asphalt, but, at the same time, asphalt is used, O. K.'d, and paid for by the Air Force.

But that's not all.

The Air Force is building more asphalt pavements, the very kind it has banned. One example is shown at a Strategic Air Command base in Columbus, Miss., where a 10,000-foot asphalt concrete runway is now under construction.

And here are more Air Force contradictions:

Strategic Air Command Commander, Gen. Curtis E. LeMay said (as quoted by Newsweek, January 7, 1957): "* * * We have only two bases which can handle B–52's—at Merced, Calif., and at Limestone, Maine." Both of these fields have asphalt pavements.

Maj. Gen. L. B. Washbourne (Assistant Chief of Staff, Installations, United States Air Force, February 1956) said: "* * * contractors, by and large, do not produce laboratory-type blacktop pavements on our bases."

He implied that there aren't enough contractors who can build the laboratory-type of material which the Air Force requires. Yet, half of our military pavements are of asphalt concrete and continue to serve under heavy operating conditions.

Perhaps General Washbourne can explain who built these pavements which the Air Force accepted and paid for, and which our aircraft are now using?

If asphalt isn't serviceable, why is it accepted by the Air Force's installations engineers? Isn't someone—either General Washbourne, who flatly condemns all asphalt, or the Air Force's installations engineers who approve it—very wrong?

Congress, the Air Force, contractors and engineers have acknowledged asphalt's suitability for military paving, based on the material's performance. Here are a few examples:

The 83d Congress said (at the 1954 Hess hearings): "* * * the Air Force verified that there is not adequate engineering support to justify paying a 5-percent premium for concrete airstrip paving over asphalt pavement in noncritical areas on airfields. The same conclusion was reached by the subcommittee."

United States Air Force pavement engineer, P. T. Sutton (Air Proving Ground Command, Eglin Air Force Base, Fla., at the Pavements Maintenance Conference May 1956): "* * * As far as I have ever seen, asphalt concrete pavements, subjected to moving traffic only, have held up excellently except in a few cases of improper design or where proper control was not exercised during construction. Damage to asphalt concrete runways from jet blast effect or fuel spillage is only slight."

Paving contractor, Horace S. Kerr, said (vice president of the H. B. Zachry Co., builders of military pavements, May 1957): "* * * Our inspection of the asphalt concrete pavements which we placed on runway extensions and taxiways at Bergstrom AFB, Tex., reveals that they are in perfect condition after 4 years of service with practically all types of military aircraft. These aircraft have used the field extensively: B–47's, B–36's, F–84F's, F–24G's and KB–29 tankers. There are some indications of fuel spillage but the asphalt concrete shows no sign of deterioration or distress from it. There is no indication of surface maintenance having been required on this pavement."

Asphalt concrete's performance at scores of Air Force bases indicates its serviceability and durability.

Twice as much asphalt paving as portland cement concrete was used on runways and an equal amount on taxiways, at 88 major Air Force bases in the United States, according to figures that General Washbourne gave this committee in 1954. This included critical areas.

	Pavement use	Asphalt concrete (square yards)	Portland cement concrete (square yards)
Noncritical areas	Runways	21, 973, 706	10, 528, 013
Critical areas	Aprons	4, 816, 571	18, 112, 636
	Taxiways and warm-up pads	10, 998, 424	9, 211, 371

Today, 3 years later, these pavements are still serving satisfactorily on runways and in critical areas. The Air Force's fear in 1954 that asphalt pavements would suffer extensive damage from jet blast and fuel spillage has failed to materialize.

Contractors and consulting engineers have verified asphalt's serviceability on a recent inspection of nine SAC Air Force bases and municipal fields. Fields visited included: Dow, Loring, Pinecastle, Homestead, Lockbourne, Altus, Tinker, Kelly and Bergstrom Air Force Bases.

Three Air Force complaints: The Air Force's complaints about asphalt are the reasons given for banning this material for pavements. The complaints fall into three categories: I. Pavement failures; II. uneven surfaces; III. loose particles.

Let's examine the facts:

Air Force complaint No. 1:

PAVEMENT FAILURES FROM ALL CASES

Every alleged asphalt failure was traced to other factors.

Investigating groups included the Air Force itself, the Corps of Engineers, the Highway Research Board, the Asphalt Institute, and consulting engineers.

Yes, there were difficulties—but from other causes. The fault was traced to:

Poor design;

Poor construction;

Poor maintenance; and

Poor coordination between aircraft research and design; and pavement construction.

Just to mention a few opinions of the Air Force's and the corps' experts:

United States Air Force Pavement Engineer P. T. Sutton said (Air Proving Ground Command, Eglin AFB, Fla., at the pavements maintenance conference, May 1956): "* * * Damage to asphalt concrete runways from jet blast effect or fuel spillage is only slight. The few cases of rutting of bituminous (asphalt) concrete pavements in the channelized area from bicycle type landing gear, along with some surface flushing which has occurred, are the exceptions which can be eliminated by the proper design mix and good control and inspection during construction."

Corps of Engineers W. J. Turnbull (Chief, Soils Division, Waterways Experiment Station, Vicksburg, Miss., at NBCA's second convention, February 1957) said: "* * * In the case of the several fields listed (March, Pinecastle, Altus, and Davis-Monthan AF Bases), with flexible (asphalt concrete) pavements which have been giving trouble as a result of channelized traffic of B–47 aircraft, no trouble with the asphalt concrete has developed except in one instance where the latter did not meet design requirements."

Air Force complaint No. 2.

UNEVEN PAVEMENT SURFACES

Bouncing (porpoising) of aircraft has been blamed entirely on asphalt pavements by the Air Force. Investigation has revealed that this also happens on portland cement concrete pavements.

The Air Force proposed to eliminate this bouncing, so dangerous to crews and planes, by specifying "absolutely smooth pavements." These requirements were met by asphalt contractors. Then suddenly, on March 13, 1957, the Air Force relaxed its requirements.

Why?

Isn't bouncing dangerous any more?

The Corps of Engineers, South Pacific Division, conducted a grade control conference in San Francisco, Calif., on January 25, 1956, to deal with this problem. Attended by the Corps, the Air Force, the Asphalt Institute, and leading engineers and contractors, the problem and possible remedies were discussed.

It was clearly indicated that aircraft bounced on all pavements, and that many factors are involved in addition to pavements.

Air Force complaint No. 3:

LOOSE PARTICLES FROM BROKEN PAVEMENTS

Jet engine damage from loose particles has been blamed entirely by the Air Force on asphalt pavements.

The recent Department of Air Force appropriations hearings[1] indicate that damaged Portland cement concrete pavements are responsible in a large measure for jet engine damage.

Col. H. R. Page (Chief, Equipment Programs Division, Director of Materiel Programs, United States Air Force, May 1957) said: "* * * In regard to a related item, a recent study covering a 22-month period indicates that a total of 5,981 jet engines were removed for foreign object damage reasons. The estimated repair costs on these engines were $32.3 millions. The runway sweepers provided for in this estimate play an essential part in protecting our jet aircraft engines against this type of damage."

Hon. G. A. Mahon (Chairman, Subcommittee on Appropriations, May, 1957) asked: "* * * If the runways were perfectly clean and there were none of these objects on the runways, do you mean we would probably have saved $30 million?"

Col. H. R. Page said: "* * * Yes; to the extent that we can identify the foreign objects—these objects that we believe were picked up from the pavement. *By far the majority are nuts, bolts, small pieces of gravel, chips of concrete, and things of that kind that* were sucked up by the air intake of the engine." [Editor's italic.]

Talking about the lack of adequate maintenance at many Air Force Bases, Col. B. L. Neal (Chairman, Operational Bases Panel, Director of Operations, United States Air Force, May 1957) said: "* * * We have a listing of major repair projects by base which represent known requirements at this time. Only those projects of highest priority will be accomplished.

For example, the listing includes projects such as those for the repair of aircraft parking aprons and taxiways at Kinross Air Force Base.

This base is the home of a squadron of fighter-interceptor aircraft, with part of the squadron being in a 5-minute alert status. The danger of an interceptor taxiing out for an interception mission is extremely critical because of large areas of broken and chipped concrete.

To eliminate the possibility of aborting a mission, it is essential that 170,000 square yards of taxiways and aprons be overlaid at an estimated cost of $766,000."

The National Advisory Committee for Aeronautics found that loose particles from portland cement concrete pavements were sucked into jet planes more readily than from asphalt pavements. These findings, based on research, revealed that particles lodged in Portland cement concrete joints are blasted up—as high as 8 feet and sucked into jet engines. Particles move sideways on smooth asphalt surfaces, and not up.

These are the facts on the Air Force's complaint based on operational experience.

There is one more. It is an engineering test, which ended up as a marathon and attracted a great deal of attention about a year ago.

After banning asphalt (December 20, 1955) the Air Force proceeded to test it at Kelly Field, Tex. (May 5, 1956).

Why was the Air Force so interested in testing asphalt 4½ months after rejecting it?

Asphalt's inability to pass a theoretical test at Kelly Field doomed its future in military paving. Incidentally, this "not-good-enough" test strip has been serving as a connecting taxiway under actual traffic conditions for the past year. It is still in excellent condition.

It was a "winner-take-all" decision.

The test was made under conditions so severe, they could never be duplicated, even in part, under operating conditions. Here is what the contractor who built the pavement, has to say about this test. He is H. S. Kerr, vice president of the H. B. Zachry Co. of San Antonio, Tex. "* * * It is my opinion that the severely accelerated, concentrated loads and methods of application to the test section do

[1] "Damage to Jet Engines Due to Debris on Airfield Pavements." Excerpts pertaining to Asphalt Concrete for Military Paving; pp. 346 and 347 of the recent hearings on Department of the Air Force appropriations for 1958, hearings before the Subcommittee on Appropriations, House of Representatives, 85th Cong., 1st sess. Subcommittee on Department of the Air Force Appropriations: George H. Mahon, Texas, chairman; Jamie L. Whitten, Mississippi; Errett P. Scrivner, Kansas; Samuel W. Crosby, executive secretary to the subcommittee.

not represent in any degree the type of normal aircraft traffic that will be applied to the runway pavement at any time during its years of service. The asphalt concrete pavement as constructed on the Kelly Field runway will adequately serve any type of aircraft now in use. Also, the test loads were applied to a newly constructed pavement before it had seasoned and reached its full strength. This test strip is now satisfactorily serving aircraft operations.

"An inspection of the asphalt concrete after a year's usage reveals that the pavement is in excellent condition.

A few simple calculations clearly show the impossibility of ever achieving in actual operations, the theoretical landings used at Kelly for the test. One estimate, by engineers who are aware of aircraft traffic at some of our busiest airfields, reveals that it would take 30 months to duplicate the landings (coverages) applied at Kelly within a few weeks. Another calculation (assuming that there are 1,200 B–52's and B–47's) shows that the entire fleet of these aircraft would have to take off and land 2½ times each day at every SAC base at the same time—to duplicate the test load conditions imposed on the Kelly test sections.

At first glance it appeared that asphalt had not passed. But then the Corps of Engineers found it had overlooked two factors—it had agreed to too many coverages and had not used the right mixture for the test. So it tested again—with the same coverages but with the proper ingredients. This time, the asphalt stood firm—under the same conditions and number of passes as in the Kelly test. When the proper mix was used, it withstood the test.

The Corps then advised the Air Force that its new formula had withstood the test. To everyone's surprise the Air Force did not respond.

Any material tested under the wrong conditions will show distress. And so will the taxpayers, if good engineering judgment is not used in establishing realistic needs.

The Air Force knows that it can't do completely without asphalt concrete in its paving program. This in part, explains the Air Force's contradictory actions.

General Washbourne has known that all pavements have difficulties, even when he publicly made asphalt the target of all his negative remarks.

His own statement at the Pavements Maintenance Conference, May 27–31, 1956, showed it:

"* * * Only increased maintenance can make up for underdesign. You will be confronted with spalling, broken slabs, base failures, and similar problems for a long time to come."

But, feelings, rather than engineering facts or operational requirements seem to have determined the Air Force's preference for portland cement concrete.

THE AIR FORCE KNOWS THESE FACTS

1. Asphalt concrete pavements are now in use at both military and civil airports, having satisfactorily served under all traffic conditions for over 25 years.

2. Asphalt concrete runways built years ago are now handling much heavier traffic than originally designed for; yet they are in A–1 condition.

3. Asphalt concrete is widely and successfully used to strengthen and repair distressed portland cement concrete pavements.

4. Asphalt concrete pavements are built fast by skilled contractors, and can be used immediately without tying up airport facilities for weeks.

5. Asphalt concrete pavements are built to the Air Force's exacting specifications. In one case, at the Robins AFB, Augusta, Ga.

"The asphalt checks to closer tolerances (1/16 inch in 16 feet) than the portland cement concrete ends," according to Henry H. Claussen, president of the Claussen-Lawrence Construction Co., of the same city, builders of the runway.

6. Asphalt concrete serves under all load and traffic conditions, even within many critical blast and fuel spillage areas.

7. Asphalt concrete is being constantly improved. It lends itself to the use of local aggregates in 95 percent of paving contracts. Only asphalt—about 5 percent of the total construction material—needs to be transported.

8. Asphalt concrete does not break up into large fragments under bombing. Asphalt mixtures can be stocked in advance so that in an emergency, bombed areas can be immediately repaired.

9. Asphalt concrete costs less than competitive methods of construction in almost all cases, although its qualities are at least equal to and in many cases superior to other types of paving.

Cost comparisons of new, resurfaced and repaired pavements at many Air Force bases show clearly that asphalt concrete costs less than portland cement concrete, frequently half as much. These are shown on the following five pages.

COST COMPARISONS OF NEW CONSTRUCTION

PORTLAND CEMENT CONCRETE VS. ASPHALT CONCRETE FOR MILITARY PAVING

AIR FORCE BASE PAVEMENT TYPES	EXTRA COST FOR PORTLAND CEMENT CONCRETE	PAVEMENT COST PER SQ. YD. (DOLLARS)
NATIONWIDE, 1952		
ALL PAVEMENTS: (Brig. Gen. R. E. L. Eaton, Ref. 1)		
Portland Cement Concrete.....	50% Extra	
NATIONWIDE, 1953 - 1954		
HEAVY DUTY: (E. C. Peck, Ref. 2)		
Portland Cement Concrete.....	88% Extra.....	$7.05
Asphalt Concrete		$3.76
NATIONWIDE, 1953 - 1954		
LIGHT DUTY: (E. C. Peck, Ref. 2)		
Portland Cement Concrete.....	60% Extra.....	$5.26
Asphalt Concrete		$3.30
NATIONWIDE, USAF PRICING GUIDE, 1956		
HEAVY DUTY: (E. C. Peck, Ref. 3)		
Portland Cement Concrete (17").....	63% Extra.....	$10.50
Asphalt Concrete		$6.50
NATIONWIDE, USAF PRICING GUIDE, 1956		
LIGHT DUTY: (E. C. Peck, Ref. 3)		
Portland Cement Concrete (10").....	55% Extra.....	$8.50
Asphalt Concrete		$5.50

COST COMPARISONS OF NEW CONSTRUCTION

PORTLAND CEMENT CONCRETE VS. ASPHALT CONCRETE FOR MILITARY PAVING

AIR FORCE BASE PAVEMENT TYPES	EXTRA COST FOR PORTLAND CEMENT CONCRETE	PAVEMENT COST PER SQ. YD. (DOLLARS) $ 0 2 4 6 8 10 12 14
PLATTSBURG AFB, NEW YORK, 1951-1954		
HEAVY DUTY: (B. Gray, Ref. 4)		
Portland Cement Concrete.....	65% Extra.....	$6.07
Asphalt Concrete		$3.73
HOMESTEAD AFB, FLORIDA, 1951 - 1954		
HEAVY DUTY: (B. Schumacher, Ref. 5)		
Portland Cement Concrete.....	180% Extra.....	$7.00
Asphalt Concrete		$2.50
ELGIN AFB, FLORIDA, 1955		
CHANNELIZED SECTION: (Smith Eng. & Const. Co., Ref. 6)		
Portland Cement Concrete (13")....	134% Extra.....	$7.97
Asphalt Concrete (4")		$3.40
RUNWAY (NON-CHANNELIZED):		
Portland Cement Concrete (12")....	113% Extra	$5.75
Asphalt Concrete (4")		$2.70
MAIN TAXIWAY:		
Asphalt Concrete (4")		$3.56
CROSS TAXIWAY:		
Asphalt Concrete (4")		$2.86

COST COMPARISON OF RESURFACING

PORTLAND CEMENT CONCRETE VS. ASPHALT CONCRETE FOR MILITARY PAVING

AIR FORCE BASE PAVEMENT TYPES	EXTRA COST FOR PORTLAND CEMENT CONCRETE	PAVEMENT COST PER SQ. YD. (DOLLARS) $0 2 4 6 8 10 12 14
LOCKBOURNE AFB, OHIO, 1951		
HEAVY DUTY: (S. A. Baker, Ref. 7)		
Portland Cement Concrete 11"	90% Extra	
Portland Cement Concrete 12"	(av.)	$6.86 (av.)
Asphalt Concrete (6")		
Asphalt Concrete (7")		$3.60 (av.)
ALEXANDRIA AFB, ALEXANDRIA, LA.		
HEAVY DUTY: 1955		
Portland Cement Concrete (13") (av.).....	83% Extra	$6.10
Asphalt Concrete (4" - 9")		$2.86
SELFRIDGE AFB, MT. CLEMENS, MICH., 1956		
LIGHT DUTY: (A. A. Anderson, Ref. 8)		
Portland Cement Concrete 1" - 1-1/2".....		$3.49

COST COMPARISONS OF REPAIRS

PORTLAND CEMENT CONCRETE VS. ASPHALT CONCRETE FOR MILITARY PAVING

AIR FORCE BASE PAVEMENT TYPES	EXTRA COST FOR PORTLAND CEMENT CONCRETE	PAVEMENT COST PER SQ. YD. (DOLLARS) $ 0 2 4 6 8 10 12 14
MOUNTAIN VIEW AFB, COLORADO, 1956		
LIGHT DUTY: (L. B. Crowley, Jr., Ref. 9)		
Portland Cement Concrete		$14.90
Asphalt Concrete		$4.00
PINECASTLE AFB, FLORIDA, 1956		
HEAVY DUTY: (Charles E. Cobb, Ref. 10)		
Asphalt Concrete		$1.24

REFERENCES FOR COST COMPARISON CHARTS

1. Brig. Gen. R. E. L. Eaton's letter of September 2, 1952 to the Honorable Carl Vinson.
2. Earle C. Peck, supervising civil engineer, Headquarters, Technical Training Air Force, presented a paper, "Pavement Problems of Air Training Command," at the Pavements Maintenance Conference May 28, 1956 at Colorado Springs, Colo. His paper dealt with military airfield pavement contracts for the May 1, 1953, to June 30, 1954 period. The information was obtained from the August 1955 Department of Defense special report entitled 'Effects of Military Aircraft on Airfield Pavements."
3. Earle C. Peck's reference to the USAF Pricing Guide at the Pavements Maintenance Conference.
4. Bernard Gray, the Asphalt Institute's former president, presented price comparisons between new portland cement concrete and asphalt concrete construction for the Plattsburgh AFB, N. Y., 1951–54, before the Hess committee (Feb. 3–8, 1954).
5. Byron Schumacher, chief engineer of the Asphalt Paving Co., Coral Gables, Fla. Cost comparisons between new portland cement concrete and asphalt concrete construction at Homestead AFB, Dade County, Fla.
6. Smith Engineering & Construction Co., Pensacola, Fla.
7. Scott A. Baker, executive secretary of the Michigan Asphalt Paving Association, Inc., on his May 14, 1957 inspection of the Lockbourne AFB, Ohio, obtained this cost information for pavement resurfacing and strengthening carried out during 1951.
8. A. A. Anderson, chief highway consultant, Portland Cement Association, presented the May, 1956, resurfacing costs of the Selfridge AFB, Mt. Clemens, Mich., at the Pavements Maintenance Conference.
9. Leslie B. Crowley, Jr., Chief, Pavements and Railroads Section, Maintenance Division; Assistant Chief of Staff, Installations Headquarters, USAF, presented a paper entitled "Engineering Supervision of a Scheduled and Systematized Program for Maintenance and Repair of Pavements," at the Pavements Maintenance Conference. Repair costs of Mountain View AFB, Colo., were included.
10. Charles E. Cobb, president, Jackson Construction Co., Jacksonville, Fla.

EXHIBIT MATERIAL FROM THE ASPHALT INSTITUTE

(Presented for the information of the Subcommittee on Special Investigations of the Committee on Armed Services, United States House of Representatives, May 13, 1957)

EXHIBIT A

THE ASPHALT INSTITUTE CHRONOLOGY OF EVENTS DATING FROM FEBRUARY 1954 HEARING

On July 9, 1954, 5 months after the conclusion of the hearing on airstrip paving policy before the Subcommittee on Defense Activities of the House Armed Services Committee, Chief Engineer Arvin S. Wellborn of the Asphalt Institute, addressed a letter to the Honorable William E. Hess, subcommittee chairman, advising him that the Air Force was maintaining in effect the 5-percent cost differential favorable to concrete paving.

An exchange of correspondence followed between the chairman of the subcommittee and Air Force officials which culminated with this letter, dated August 16, 1954, from Mr. John M. Ferry, Special Assistant for Installations, United States Air Force, to Mr. Hess:

DEPARTMENT OF THE AIR FORCE,
Washington, August 16, 1954.

Hon. WILLIAM E. HESS,
Chairman, Subcommittee on Defense Activities,
Committee on Armed Services,
House of Representatives.

DEAR MR. CHAIRMAN: On July 30, 1954, in answer to inquiry from you concerning the Air Force's continued use of a 5-percent differential in favor of concrete versus asphalt as an airstrip paving material, I informed you we would complete a reevaluation of this paving subject during the month of August.

This is to inform you that we have completed a review of all available in-

formation from the field which has a bearing on the subject. While we are completely convinced that 100-percent concrete paving has a definite advantage as compared to a combination of concrete in the critical areas and asphalt in the noncritical areas, we have been unable to collect adequate engineering backup, as reflected by maintenance costs, to substantiate this view. It is apparent the problem does not lend itself to a simple conclusive solution based on the facts secured by this short-term study. We have, therefore, suspended premium payments for cement concrete in noncritical runway airfield areas. Instructions are being prepared for issuance to all Air Force and Corps of Engineers personnel concerned. The existing provisions specifying concrete in critical areas and the alternative bid schedules will remain in force until further notice.

It is my understanding that this action is in accordance with the views of your committee which held hearings and secured information from many interested sources.

Sincerely yours,

JOHN M. FERRY,
Special Assistant for Installations.

Meanwhile, at the invitation of the Department of Defense, a special task force committee of paving specialists under the direction of the highway research board of the National Research Council of the National Academy of Sciences conducted a survey of 27 military airbases during the latter part of 1954 to determine the effects of military aircraft on airfield pavements. In February of 1955, the committee filed its report which concluded:

"Differences in costs of the two principal types of pavement are not so great that initial cost or maintenance cost should determine selection of pavement type for critical areas exposed to repeated fuel spillage or heat and blast from jet engines. On the other hand, the differential in construction costs of the two types of pavement is frequently sufficiently great to justify the use of the less costly type in those noncritical areas where it is adequate and satisfactory."

Thus, the findings of your committee in open hearing were substantiated by a group of competent and expert investigators whose special knowledge was solicited by the Defense Department. Yet, less than 3 months later, on May 2, 1955, we find a ranking Defense Department official proposing to crowd flexible pavements off all primary taxiways by an exercise in semantics. He would broaden the interpretation of the phrase "critical areas" to include all primary taxiways. Reference is made in the following memorandum:

ASSISTANT SECRETARY OF DEFENSE,
Washington, D. C., June 28, 1955.

Properties and installations.
Memorandum for the Secretary of the Air Force.
Subject: Change in designation of critical areas for airfield pavements.

The proposal made by Mr. Ferry in his memorandum of May 2, 1955, that primary taxiways at multipurpose use air installations be constructed solely of rigid-type pavement is concurred in on an interim basis for the fiscal year 1956 program pending completion of tests on flexible pavements.

It is assumed that an adequate accelerated test program will be authorized without delay in order that necessary design data may be established for the use of flexible pavements under concentrated channelized aircraft traffic.

FRANKLIN G. FLOETE.

Copy furnished: Secretary of the Navy.

On the same date, the following memorandum was issued by the office of Col. Robert R. Conner, Director of Construction:

DEPARTMENT OF THE AIR FORCE,
HEADQUARTERS, UNITED STATES AIR FORCE,
Washington, D. C.

Memorandum for Chief of Engineers, Department of the Army, Washington, D. C., Attention: Enger.
Subject: Design of primary taxiways at multipurpose use Air Force installations.

1. In consonance with the attached copy of memorandum from the Assistant Secretary of Defense dated June 28, 1955, it is requested that primary taxiways at multipurpose use installations be constructed solely of rigid pavement. This change in criteria will apply to the fiscal year 1956 MCP only, including Grand Forks Air Force Base and the Traverse City project, regardless of status of design.

2. Subject taxiways will be designed according to the thickened center section concept as requested in our letter dated April 27, 1955, subject, design of heavy load airfield pavements at Air Force installations, and implementing instructions recently issued by your office.

3. It is proposed to hold a conference in this headquarters during the week of July 18, 1955, to develop procedures for the conduct of accelerated flexible pavement investigational program referred to in attached memorandum. It is requested that representatives of your office and the Flexible Pavement Laboratory, WES, participate. Your office will be advised within the next few days as to the exact date and time of the conference.

For the Chief of Staff:

ROBERT R. CONNER,
Colonel, United States Air Force, Director of Construction,
Assistant Chief of Staff, Installations.

Subsequently, the following design criteria memorandum was issued to all division engineers of the Corps of Engineers, United States Army:

DEPARTMENT OF THE ARMY,
CORPS OF ENGINEER,
Washington, D. C., July 18, 1955.

Subject: Design of primary taxiways at multipurpose use Air Force installations.
To: Division Engineers, Corps of Engineers, United States Army.

1. Reference is made to OCE all-division letter dated June 15, 1955, subject: "Revision to design criteria for airfield pavements."

2. It is desired that primary taxiways at multipurpose use Air Force installations be constructed solely of rigid pavement. This change in criteria will apply only to the fiscal year 1956 military construction program and will be implemented regardless of status of design.

By command of Major General Sturgis:

PAUL P. TROXLER,
Colonel, Corps of Engineers,
Assistant for Engineering and Contracts, Military Construction.

In the weeks that followed, the Asphalt Institute heard disquieting rumors from the field to the effect that increasingly larger noncritical pavement areas at Air Force bases were being established by criteria change as areas of cement concrete construction exclusively. Chief Engineer Wellborn addressed the following letter to Assistant Secretary of Defense F. G. Floete:

THE ASPHALT INSTITUTE,
College Park, Md., December 19, 1955.

Hon. FRANKLIN G. FLOETE,
Assistant Secretary of Defense,
The Pentagon Building, Washington, D. C.

MY DEAR MR. SECRETARY: It was my privilege to serve as a liaison representative on the Highway Research Board Special Committee on Effects of Military Aircraft on Airfield Pavements. This is the committee formed at your request by the National Academy of Sciences to perform field investigations and studies in order to make recommendations to the Department of Defense in establishing a sound policy on the construction and maintenance of pavements for military airfields.

On April 1, 1955, a status report was submitted to you by Committee Chairman Ralph A. Moyer which included tentative recommendations. The final report, which included the condition survey of airfield pavements, maintenance recommendations, findings and conclusions, was submitted to you under date of August 1955.

The Asphalt Institute concurred in most of these items as they substantiated our testimony and that of the United States Army Corps of Engineers in the February 1954 hearings before the Subcommittee on Defense Activities of the Committee on Armed Services, House of Representatives.

In view of the above-referenced report, we assume present policy on airfield pavements will continue without substantial change. However, if there should be a special request to change the policy we would appreciate an opportunity to confer with you before the change is made effective.

Very truly yours,

ARVIN S. WELLBORN, *Chief Engineer.*

To this communication Mr. Floete responded as follows:

ASSISTANT SECRETARY OF DEFENSE,
Washington, D. C., January 6, 1956.

Re properties and installations.

DEAR MR. WELLBORN: This is in reply to your letter dated December 19, 1955, concerning the Highway Research Board study on effects of military aircraft on airfield pavements and the Department of Defense policy for airfield pavements.

The study and report have provided current information and data for consideration in the development of present Department of Defense policy. As you know, rigid-type airfield pavement has been specified as a requirement for critical areas for some time and either flexible-type or rigid-type airfield pavement for noncritical areas on the basis of lowest first cost. This is still the policy of the Department of Defense.

From time to time, there have been, and probably will continue to be, adjustments made between critical and noncritical areas as determined necessary to meet operational requirements. Because it must maintain uninterrupted operational readiness at certain bases within the United States, recently the Air Force has been permitted to consider certain primary runways and taxiways for principal combat and combat-support aircraft to be critical operational areas. Construction of rigid-type pavement in such critical operational areas will be permitted whenever necessary for sustained and capacity operation. No major modification in present policy is contemplated at this time.

Although this office cannot be committed in advance to confer with persons outside the Government on matters of policy, we shall be pleased to reply to specific requests for information, as appropriate, or to discuss informally areas of mutual interest to the Government and the Asphalt Institute.

Sincerely yours,

FRANKLIN G. FLOETE.

It will be noticed that this exchange of letters developed two points of special significance. It introduced, for the first time, the extension of the term "critical areas" to include runways as well as taxiways, and intimated strongly that further extensions of the term would be made at the convenience and discretion of the Air Force. Mr. Floete's assurance that there had been no change in construction policy had a hollow ring, particularly in the light of a memorandum, issued over his signature on December 20, 1955, presumably on the very day he received Mr. Wellborn's letter of inquiry.

DECEMBER 20, 1955.

Memorandum for the Secretary of the Air Force
Subject: Selection of airfield pavement types for Air Force construction.

Reference is made to your memorandum dated October 28, 1955, requesting that discontinuance of use of bituminous airfield pavements for appurtenance construction—such as shoulders, runway overruns, and erosion control areas—be approved.

Primary runways and primary taxiways for sustained and full capacity operations of principal combat aircraft or principal combat support aircraft may be considered to be critical operational areas.

Rigid-type airfield pavement may be provided in critical operational areas when necessary for required sustained and full capacity operations of principal combat or combat-support aircraft.

When provision of only one kind of airfield paving is to be considered that kind of pavement is to be clearly identified and the identification is to be included and part of the name or description of each item affected. This identification is to be continued through all phases of programing, authorization, funding, construction and reporting of each facility.

For all other airfield pavements except as otherwise finally approved by this office, the provision of either flexible or rigid-type pavement will continue to be made on an economic basis by direct comparison of first cost.

FRANKLIN G. FLOETE,
Assistant Secretary of Defense Properties and Installations.

Here we have, by arbitrary dictum, a rather drastic change of paving policy being enunciated by a responsible Defense Department official who, in the same communication, denies any policy change. One month after Mr. Floete's reply to Mr. Wellborn, Maj. Gen. Lee B. Washbourne, Assistant Chief of Staff for

Installations, USAF, addressed a meeting of the Associated General Contractors in New York City and was widely reported in the press as declaring that all primary taxiways and active runways now must be built of cement concrete. He went one step further in offering, as the reason, that "concrete can take it and blacktop can't."

During the same month of February 1956, General Washbourne appeared before a subcommittee of the House Appropriations Committee and the following colloquy took place:

"Mr. MAHON (chairman of the subcommittee). What kind of paving are you doing now as between asphalt and concrete?

"General WASHBOURNE. We are essentially operating a portland cement concrete pavement program, especially within the United States; not altogether concrete but mostly concrete.

"Mr. MAHON. Have you any complaints from the producers of asphalt stating that asphalt could perform this function for less money and as well as concrete? What is the situation from that standpoint?

"General WASHBOURNE. For the past 3 years we have been developing this problem of how much we would have to go to concrete in order to sustain jet operations. As we go to concrete we would naturally not use as much asphalt-type pavement as we have before, percentagewise.

"The asphalt industry, the petroleum people generally, assert that asphalt pavements can be built to do the Air Force job, and they oppose an extension of the portland cement concrete criteria.

"We very reluctantly have to disagree with them because we find increasingly that only concrete pavement will stand up under these jet operations, and we have since last fall had Secretary of Defense concurrence to build concrete taxiways and concrete primary runways in addition to the aprons and other things that have been concrete for some time past.

"We will not go into that concrete program overnight because it is not practicable to just stop everything and convert our designs to concrete, but the pavement that is in this program will largely be designed for concrete and built that way.

"Mr. MAHON. In other words, out of the $300 million, using a rough figure for paving, it would be——

"General WASHBOURNE. I would expect in excess of three-fourths of it would be concrete."

The Air Force moved swiftly to consolidate its position. On March 6, 1956, the following military construction bulletin was issued by the Chief of Engineers, Corps of Engineers, United States Army:

"MILITARY CONSTRUCTION BULLETIN No. 56–52

"*Criteria for selection of pavement type at Air Force installations*

"1. All previous correspondence pertaining to the selection of pavement type is rescinded.

"2. The selection of pavement type will be based on the following criteria:

"(*a*) 'Primary use pavement' at Air Force installations will normally be constructed of portland-cement concrete.

"(*b*) 'Primary use pavement' is defined as follows:

"(1) All paved areas on which aircraft are regularly parked, serviced, maintained, or preflight checked.

"(2) All runways having adequate length, width, and approaches to permit sustained use by combat or combat-support aircraft.

"(3) All taxiways connecting paved areas referenced in subparagraphs (1) and (2) above.

"(*c*) Other airfield pavement will be constructed of either portland-cement concrete or an acceptable type of bituminous pavement, selection being based on low first cost.

"(*d*) It is recognized that conditions will arise when construction with portland-cement concrete may not be practicable or economically feasible. In these cases OCE, attention ENGER, and the AFIR will be advised concurrently. The letter will include estimate of savings affected by the use of flexible pavement and other pertinent data.

"(*e*) Headquarters, United States Air Force, advises that all future actions on the part of the Air Force relating to programing, authorization, funding, con-

struction, and reporting will clearly state that the specific use of portland-cement pavement is intended where such is the case."

This construction bulletin went on at length to define heavy-load and light-load conditions with the explanation that "heavy-load design will be used for all airfield pavements at all Air Force installations" except under special conditions which virtually eliminated flexible paving from all active duty Air Force bases.

The Air Force nailed it down with its installations engineering criteria-memorandum of May 25, 1956, No. 56–34 (100.1.2) which restated the earlier construction bulletin with no change in the language. Pavement policy had undergone a substantial change while remaining unchanged through the simple expedient of broadening the meaning of the term "critical areas" to encompass virtually every square yard of pavement on the airfield.

In the meantime, the Air Force had supported its rapidly shifting construction policy position by citing pavement distress at several heavy-bomber bases. Alleged pavement failures under B–47 bomber traffic were reported at the following fields: Castle AFB and March AFB in California, Williams AFB and Davis-Monthan AFB in Arizona, Tinker AFB and Altus AFB in Oklahoma, and Pinecastle AFB in Florida. With the permission of the Department of Defense, these bases were inspected by field engineers of the Asphalt Institute early in 1956.

Institute engineers found that only three of the bases showed any pavement distress that could not be corrected readily with normal maintenance measures. In every case, the severely distressed pavement could be attributed directly to faulty design and/or construction. On one base they found that the engineering fundamental of installing proper drainage had been largely neglected. On another, they found that areas showing distress had not been properly compacted during construction. The survey by institute engineers confirmed the findings of the Highway Research Board task force inspection team of 1955 which reported a serious neglect of routine maintenance at all Air Force bases.

Meanwhile, it will be recalled that in his interim criteria memorandum of June 1955 approving exclusive concrete construction of primary taxiways, Assistant Secretary of Defense Floete had declared, "It is assumed that an adequate accelerated test program will be authorized without delay in order that necessary design data may be established for the use of flexible pavements under concentrated channelized aircraft traffic." This was to be a three-phase program including theoretical design, laboratory testing of the theoretical design, and field construction under standard contract conditions.

The first two phases of the program had demonstrated to the satisfaction of the engineers at the Flexible Pavements Branch, Waterways Experiment Station, United States Corps of Engineers at Vicksburg, Miss., that flexible pavements could perform the assignment given them by the Air Force. The third phase of the accelerated test program, commonly referred to as the Kelly test because the test pavement was constructed at Kelly AFB in Texas, was launched on May 5, 1956, and concluded on June 4. The flexible pavement test section was declared a failure at this point. A full discusion of this test and the curious circumstances under which it was conducted is contained in a supplementary exhibit (D).

The misleading nature of the Kelly AFB pavement test was confirmed by the observation offered by Mr. W. J. Turnbull of the Waterways Experiment Station, Corps of Engineers, Vicksburg, Miss., June 13, 1956. Speaking at a conference on bituminous pavements at Vicksburg, Mr. Turnbull had this to say about the distressed flexible test pavement at Kelly (extracted from the minutes of the conference):

"Mr. Turnbull states it was his personal opinion that the pavement on the Kelly test section was about one-half percent too rich with respect to accelerated traffic but that it would make a good pavement for normal operations. He called attention to the fact that some of the airfield pavement in service had been subjected to up to 28,000 coverages of B–47 traffic without significant distress, whereas distress had occurred very much earlier on both the test section at Kelly and the test section at the Waterways Experiment Station. Exhibit 12 shows that all traffic was applied when pavement temperatures were 90° F. or above. A significant portion of traffic was actually applied with pavement temperatures above 120° F. This exhibit also indicates that the rate of increase in density of both the surface course and wearing course increases rapidly with increased pavement temperatures. Normal traffic on actual airfields is distributed throughout the seasons and is not all applied with the pavement

temperatures as high as those observed at the Kelly test section. It was also suggested that the rate of application of the traffic may have to be considered in evaluating the results from a test section. * * *"

This was the sober reflection of the engineer chiefly charged with the administration of a pavement test on which the Air Force seized as justification for its restrictive policy. On June 25, 1956, Mr. Wellborn addressed the following letter to Secretary of Defense Charles E. Wilson:

THE ASPHALT INSTITUTE,
College Park, Md.

MY DEAR MR. SECRETARY: Under date of May 25, 1956, the Department of the Air Force issued an Installations Engineering Criteria Memorandum, No. 56–34 (100.1.2), Subject: Airfield pavements—Selection of types, design, and alternate bid schedules. This memorandum, in effect, eliminates the use of asphalt pavement for all Air Force installations.

This development apparently started with a memorandum for the Secretary of the Air Force, dated December 20, 1955, from Assistant Secretary of Defense, the Honorable Franklin G. Floete, which permitted certain airfield areas to be redesignated as critical and therefore to be surfaced with rigid pavement types.

Elimination of flexible pavements from Air Force installations means the elimination of competition as well as a loss to the asphalt paving industry on the order of $100 million per year.

We protest the above-cited actions as being unwarranted, unsound, and inimical to the public interest, and respectfully request review and reconsideration of the criteria memorandum.

ARVIN S. WELLBORN,
Chief Engineer, the Asphalt Institute.

Five weeks later, on August 2, 1956, Mr. Wellborn received the following reply:

ASSISTANT SECRETARY OF DEFENSE,
Washington, D. C.

DEAR MR. WELLBORN: This is in reference to your letter of June 25 to the Secretary of Defense regarding the elimination of the use of asphalt pavement for all Air Force installations.

The decision to use portland-cement concrete for primary runways and primary taxiways for sustained and full-capacity operation of principal combat aircraft and principal combat-support aircraft at Air Force installations was based on actual experience with pavements constructed during the past 6 years. Because of construction costs and other considerations, this decision was arrived at only after long study and careful investigation.

Asphaltic concrete pavement is not eliminated or excluded, either by the currently published Department of Defense policy or by the Air Force implementation of it. Millions of square yards of flexible-type pavement will continue to be used. For example, in the fiscal year 1957 military construction program currently planned by the Air Force, there are included over 4 million square yards of asphaltic concrete pavement for overruns, shoulder pavements, and blast pads alone. The amount does not include the secondary runways and taxiways for which other flexible or rigid type pavement will be provided on an economic basis by direct comparison of first costs.

Airfield pavements for the direct support of Air Force combat missions within the continental United States must be ready and available at all times. Asphaltic concrete on the primary runways and taxiways, when subjected to the very heavy wheel loads, high tire pressures, and the traffic patterns of current Air Force jet aircraft, has become unstable and has failed. Various surveys and tests already have been made. Your organization has been invited to assist and participate in further tests to determine whether an airfield paving with an asphaltic concrete surface can be designed which will meet the Air Force requirements. At the present time, it appears that portland-cement concrete is the best material currently available of which hard, durable pavements with smooth surfaces and nearly uniform gradients can be designed and constructed with reasonable assurance that they can be maintained so as to meet satisfactorily the requirements for safe, efficient, and sustained full-capacity operation of modern high-density, high-speed military aircraft.

I hope that this information will serve to clarify the Air Force implementation of the current Department of Defense policy and to reaffirm the continued need of asphaltic concrete pavements at Air Force installations.

ROBERT A. MCDONALD,
Acting Assistant Secretary of Defense
(Properties and Installations).

The Air Force was still maintaining the fiction of no change in paving policy, yet we can see how far and how fast the construction criteria had changed since policy was last enunciated at the 1954 congressional paving inquiry. Mr. McDonald's letter pointed up two significant developments: Use of "surveys and tests already * * * made" to support the policy change (meaning the Kelly test) and the assurance that flexible paving could still compete for shoulder areas and runway overruns. Now, let's see how solid even that assurance is. In July of 1956 Maj. Gen. Joe W. Kelly, Legislative Liaison Director for the Air Force, replied as follows to an inquiry from Senator Thye, of Minnesota:

DEAR SENATOR THYE: I refer to your recent request for information concerning the use of asphalt for runway pavements on Air Force installations.

Pavement used in airfield construction must be highly stable and capable of enduring the loads placed upon it by jet aircraft. To withstand very heavy wheel loads and high pressures exerted by aircraft tires, runways, and taxiways must be constructed in strict conformance with rigid specifications. Parking aprons and other areas subjected to heat, blast, fuel spillage, and high concentrations of traffic, must also be constructed in conformance with specifications necessary to insure their strength and suitability.

Prior to December 20, 1955, the Air Force was constructing runways and taxiways either of asphalt or portland-cement concrete. On that date, however, the Secretary of Defense approved an Air Force request to specify the use of portland-cement concrete pavement on those runways and taxiways which would be subjected to sustained use by combat or combat-support aircraft. *The request was predicated on adequately documented evidence that runways and taxiways constructed of asphalt do not, and foreseeably cannot, adequately support combat and combat-support aircraft traffic.*

Programing and construction within the above-referenced approval authority does not necessarily mean that all future Air Force runways and taxiways will be constructed of portland-cement concrete. Asphalt may still be used for pavement construction of runways and taxiways not subjected to sustained use by combat and combat-support aircraft, and for runways and taxiway shoulders, runway overruns, and blast pads. *Choice of pavement type will be made in each instance based on operational and engineering considerations rather than on the basis of low first cost, as had been required in the past * * *.*" [Italic added.]

JOE W. KELLY,
Major General, USAF,
Director, Legislative Liaison.

Here again we find references to documented engineering support for a revolutionary change in Air Force paving policy. At the same time we learn that even the construction scraps that have been thrown to flexible paving in the way of shoulders, overrun areas, and secondary runways are tied to a barely visible string. General Kelly now clearly states that these subpavements may be paved with asphalt, but only at the discretion of the paving engineers.

Meanwhile, the Corps of Engineers resumed test studies at the waterways experiment station, Vicksburg, employing the accelerated test traffic pattern of very heavy wheel loads at high tire pressures. Reference to these studies is contained in the comprehensive letter addressed to Chairman F. Edward Hébert, of your subcommittee, by Chief Engineer Wellborn on August 28, 1956. The letter follows:

THE ASPHALT INSTITUTE,
College Park, Md.

MY DEAR MR. HÉBERT: The Asphalt Institute for the past 8½ months has conducted a comprehensive engineering survey and study of the military-airfield situation. We should now like to report our findings to you.

First, we should like to review briefly the situation as it has occurred. Your subcommittee of the Committee on Armed Services held a public hearing in February 1954, where the airfield-paving situation was thoroughly reviewed. It was brought out in this hearing that the asphalt pavements reported by the Air Force to have failed had not been designed for the heavy aircraft that had

caused the distress. The hearing also disclosed that failures of portland-cement concrete pavements had occurred for the same reason.

The conclusion reached by your subcommittee was that the properly designed and constructed flexible asphalt pavements were entirely satisfactory in areas where excessive fuel spillage and jet blast did not occur. Spillage and blast areas were accepted as being "critical" and were permitted to be constructed with portland-cement concrete exclusively.

The Air Force was reluctant to accept the findings of the subcommittee and continued with the same criteria under which it had operated by awarding pavement contracts on a 5-percent differential in favor of portland-cement concrete. Your subcommittee took further action to discontinue this restrictive policy. The Air Force finally changed its pavement criteria as of May 20, 1954, with criteria then established continuing in effect until January 1956.

Under date of December 20, 1955, the Office of the Secretary of Defense issued a memo to the Secretary of the Air Force permitting the Air Force to designate all "primary-use pavement" areas of its airfields as "critical" and to construct them with portland-cement concrete. Upon querying the Office of the Secretary of Defense as to the reason for this memorandum, we were referred to the Air Force. The Air Force stated that flexible asphalt pavements had failed wherever channelized traffic of the new B–47 bombers was applied. It cited seven Air Force bases where such failures had occurred.

The Asphalt Institute requested and was granted permission to inspect these fields. Our engineers made detailed inspections of the 7 airfields and reported that only 3 of them showed pavement distress which could not be corrected with normal maintenance procedures. Our engineers found that the severely distressed asphalt pavement was in every case the result of faulty design and/or construction. They found that proper maintenance procedures were almost nonexistent on most of the Air Force bases visited. They also found that the engineering fundamental of proper drainage had been largely neglected on one of the Air Force bases which showed severe pavement distress. On another base they found that areas showing distress had not been compacted during construction.

The United States Corps of Engineers meanwhile took steps to substantiate their claim that flexible asphalt pavements could be designed and constructed to withstand any channelized traffic that present and future aircraft would impose. The corps proposed to construct a test section at Kelly Air Force Base, Tex., to prove that asphalt pavement could be constructed to withstand channelized traffic.

This test pavement was completed and put under accelerated traffic in May 1956. After 9,000 coverages of accelerated traffic of 100,000-pound dual-wheel load the flexible pavement showed distress and was declared failed.

The Asphalt Institute and the Corps of Engineers both recognize that the Kelly pavement contained an excess of asphalt for the extreme conditions of this particular test. It is further recognized that this excess of asphalt was the principal reason for the failure. On the other hand, it is the consensus of qualified paving engineers that this pavement would have been satisfactory for B–47 and B–52 traffic applied in the normal manner. In addition, it was learned that approximately 1 percent of a so-called antistripping additive had been included in the asphalt used. The Asphalt Institute does not recommend the use of such additives in hot-mix asphalt pavements.

The procedure for conducting the Kelly accelerated traffic test was to impose loads corresponding to those of the B–47 or B–52 approximately 500 times in a 20-hour period. These loads were applied before the pavement had been permitted to cure sufficiently and when pavement temperatures were 90° F. or above. It was shown in the Kelly test that most of the applications were applied when the pavement temperature was above 120°.

Normal traffic on airfields is staggered throughout the season, nor is all traffic applied when the pavement temperatures are as high as those observed on the Kelly test section. Prototype traffic of a normal airfield is about 500 applications per month.

NOTE.—Data on B–47 traffic and pavement performance are listed in minutes of Conference on Bituminous Pavements, Corps of Engineers, United States Army, Waterways Experiment Station, June 13–14, 1956, pages 8 and 9. The tabulations are not repeated here pending clearance from Air Force through Office, Chief of Engineers.

It is quite apparent that the Kelly test imposed conditions of much greater severity than normal traffic.

Despite the extreme severity of conditions for the Kelly Air Force Base test, it is our understanding that the Air Force instructed the Corps of Engineers to design and build a pavement by normal procedures. These normal procedures provide an asphalt pavement containing the maximum amount of asphalt which the mix will tolerate and yet not become unstable under the anticipated traffic. The asphalt content is intentionally placed as high as possible for a given condition of service in order to provide maximum durability, flexibility, and pavement life. However, good asphalt pavement construction requires close control of asphalt content. Either too much or too little asphalt will lead to distress.

Thus, for the Kelly test pavement recognition should have been given to the extreme conditions of the test and the paving mix design adjusted accordingly. The Corps of Engineers has ample evidence that the asphalt content of paving mixes must be decreased as conditions of heat and traffic loading become more severe.

Upon invitation and for the purpose of cooperative effort, engineers of the Asphalt Institute and engineers of the institute's technical committee on asphalt pavement design recently visited the flexible pavement branch of the United States Corps of Engineers, Vicksburg, Miss., and observed sections of asphalt pavement which had withstood without distress over 30,000 passes of the 100,000-pound dual-wheel load in accelerated traffic. They learned that such a pavement could be constructed with the use of aggregates and asphalt obtainable almost anywhere in the United States. They also learned that asphalt pavements which had been constructed to withstand the loads of the B–47 were performing satisfactorily on Air Force bases where the pavements were designed for such loads.

We wish to emphasize that pavements properly constructed with asphalt, as well as with portland cement, whenever built to withstand the traffic imposed, have performed satisfactorily. We should also like to point out that failures of airfield pavements have occurred in concrete as well as in asphalt.

In May 1956, Headquarters of the United States Air Force sponsored a pavement maintenance conference at Colorado Springs, Colo. The proceedings of this conference have been printed and issued to the various commanders of the Air Force. These proceedings reveal that flexible asphalt pavements are completely satisfactory in all areas which were declared noncritical by your subcommittee.

At the Maintenance Conference, Maj. Gen. Lee B. Washbourne, Assistant Chief of Staff, Installations, Headquarters, United States Air Force, stated that:

"The yardage laid by the Air Force during its expansion program from 1950 to 1955 approximately 50–50; that is, half rigid and half flexible. Again, the criteria, though increased over World War II standards, were not equal to the usage that these pavements will now receive under the multimission concept."

By this statement General Washbourne admitted that the airfields built prior to 1956 had not been properly designed for the loads imposed upon them.

The paper presented before the maintenance conference by Mr. O. E. Cox, pavements engineer, Headquarters, USAF, entitled "Damage to Bituminous Pavements by Jet Fuel Spillage and by Heat," contained the following statement:

"Although our pavements criteria permits placement of portland cement concrete for a distance of 1,000 feet on the runway ends, however, in cases where we have had to replace the bituminous runway ends, it has been found necessary to replace only 300 feet of pavement."

This substantiates our claim that less than 500 feet of runway ends need be portland cement concrete.

A paper by Mr. H. E. Irvin, pavements engineer, Strategic Air Command, entitled "Some Pavements Problems in Strategic Air Command," contains the following statement:

"We have other problems caused by subsurface water. We in SAC are firm believers in adequate subdrainage of pavement bases. We haven't been able to sell our desires on subdrainage in the design of a project. If subdrainage is not placed during the original construction, it is very expensive to install at a later date."

Mr. Irvin substantiates our findings that proper drainage had been neglected on some of the airfields cited by the Air Force as unsatisfactory.

A paper delivered at the maintenance conference by Maj. William E. Luther, directorate of installations, Headquarters Command, USAF, entitled "Pavements and Railroads Problems at Headquarters Command," reviews quite thoroughly some of the failures which had occurred on rigid pavements at Bolling Air Force Base. His paper contains the following statement:

"Asphaltic pavement, on the other hand, has held up remarkably. Even though it is bad in spots, it still stands. * * *"

A paper delivered at the maintenance conference by Mr. Earle C. Peck, supervising civil engineer, Headquarters, Technical Training Air Force, USAF, entitled "Pavement Problems of Air Training Command," reviews the costs of constructing the various types of pavement. These costs show that the average for heavy-duty rigid concrete pavement has been $7.50 per square yard and that the average cost for heavy-duty flexible asphalt pavement has been $3.76 per square yard. Considering a statement that was made by General Washbourne that the Air Force now has in use more than 225 million square yards of airfield pavements, this difference in cost is of considerable magnitude.

A paper delivered at the maintenance conference by Mr. Paul T. Sutton, Air Proving Ground Command, USAF, entitled "Airfield Pavement and Railroad Maintenance Problems at Eglin Air Force Base, Fla.," contains the following statements:

"A lot of asphalt parking apron was laid in 1950, 1951, and 1952. If more of the pavements engineers had realized how rapidly propeller-driven planes were going to be replaced with jet aircraft, using an asphalt softening fuel such as they do, some of this asphalt pavement might not have been put in or, at least a protective seal could have been provided.

"Runways and taxiways were being designed and built during this time also. If more pavements people were made aware of the new type of bicycle-type landing gear to be used on the heavier planes, perhaps, some of these more recently built runways would have provided for this channelized traffic in their design."

Mr. Sutton goes on to state:

"With the exception of 1,000-foot portland cement sections of either end of the runway, however, the runway and taxiway are asphaltic concrete. I am very well satisfied with this arrangement. As far as I have ever seen, asphaltic concrete pavements, subjected to moving traffic only, have held up excellently except in a few cases of improper design or where proper control was not exercised during construction.

"Damage to asphaltic concrete runways from jet blast effect or fuel spillage is only slight. The few cases of rutting of bituminous concrete pavements in the channelized area from bicycle-type landing gear, along with some surface flushing which has occurred, are the exceptions which can be eliminated by the proper design mix and good control and inspection during construction.

"The problem, inherent with rigid-type pavements, of joint maintenance is eliminated as well as the prospect of being faced with what could be a very costly project in case of failure of the extremely thick slabs now required for channelized traffic. In the event that wheel loads are increased still further in the future, either from in-service loading or aircraft design, the flexible-type pavement will lend itself more readily to strengthening to meet these additional loads, as well as being more economical to repair in cases of pavement failure due to overloading.

"If it is decided to construct runways using a rigid pavement, certain localities, having soils with a low 'k' value and aggregates producing a flow flexural strength concrete, will have pavement thicknesses exceeding 2 feet in the channelized areas if present design methods are followed. These extremely thick slabs are going to present problems due to internal stresses set up from warping caused by temperature differential of the top and bottom surfaces. To eliminate this problem, as well as to effect a possible economy in construction, the traditional concept of rigid pavements as a slab whose strength is increased by adding to its thickness might well be discarded in favor of reinforced or prestressed sections in the channelized areas."

Needless to say, we feel that Mr. Sutton has given the correct engineering analysis to the selection of airfield pavement.

It is our understanding that the United States Air Force has approximately 350 operational bases in the continental United States and abroad, a large percentage of which have substantial areas of asphalt pavement. Notwithstanding these facts, they cited only seven instances of distress in asphalt pavements. Of these seven instances, inspections by Asphalt Institute engineers reveal only three which could not be corrected with normal maintenance facilities and procedures. These three instances are obviously the result of faulty design and/or construction. Considering the cost difference between the two types of pavement, we are of the firm opinion that the elimination of asphalt paving from

the areas declared noncritical by your subcommittee is unwarranted, unsound and inimical to the public interest.

Very truly yours,

ARVIN S. WELLBORN, *Chief Engineer.*

This communication completes the chronology of significant developments in the matter of Air Force paving policy since the adjournment of the subcommittee hearings in February 1954. Detailed engineering data on pavement inspection surveys and accelerated testing will be found in subsequent exhibit material.

EXHIBIT B–1

CONSTRUCTION AND MAINTENANCE COST COMPARISONS OF MODERN HEAVY-DUTY PAVEMENTS

Since World War II the existing mileage of so-called high-type bituminous (heavy-duty asphalt) pavement on the State highway systems of the United States has increased from 65,262 miles in 1946 to 194,295 miles in 1956. This 129,033-mile increase in modern flexible paving includes such monuments to advanced asphalt technology as those vastly successful toll roads in Maine, New Hampshire, New Jersey, Oklahoma, Kansas, and Florida.

In the same period the existing mileage of concrete pavement surface has shrunk from a peak of 95,740 miles to about 74,000 miles in spite of the fact that 18,172 miles of new concrete pavements were being laid. In other words, during the last decade some 40,000 miles of rigid pavement have either been abandoned or, more likely, salvaged with an asphalt overlay.

Here is the well-documented story of a decade of transition. In 10 years the highway engineering profession moved from almost exclusive recognition of concrete for primary highway construction to enthusiastic acceptance of flexible paving on terms of comparable strength and durability.

The lower construction costs of a flexible pavement are established beyond dispute. Figures have been compiled here to show that its maintenance costs are low, too. The story of asphalt superiority can be told in simple arithmetic (the Asphalt Institute, College Park, Md., May 1957).

NEW JERSEY TURNPIKE

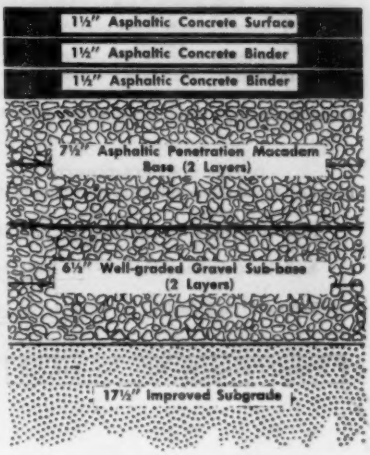
THE NEW JERSEY TURNPIKE

Length: 117.6 miles
Opened to Traffic: November 1951
Vehicles Carried (1955): 25, 888, 319
Designed for Single Axle Loadings up to 36, 000 pounds

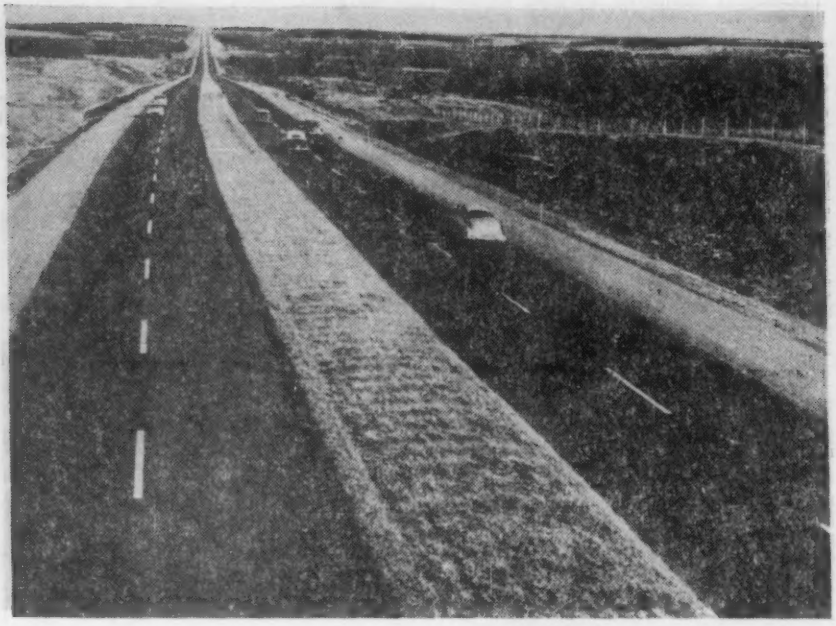
INITIAL COST COMPARISON
Based on Actual Competitive Bid Prices

Portland Cement Concrete	---	$45, 729, 568
Asphaltic Concrete	---	40, 272, 434
Total ASPHALT Saving	---	$ 5, 457, 134

ASPHALT Saving Per Mile --- $46, 404.20


1½" Asphaltic Concrete Surface
1½" Asphaltic Concrete Binder
1½" Asphaltic Concrete Binder
7½" Asphaltic Penetration Macadam Base (2 Layers)
6½" Well-graded Gravel Sub-base (2 Layers)
17½" Improved Subgrade

OKLAHOMA'S TURNER TURNPIKE



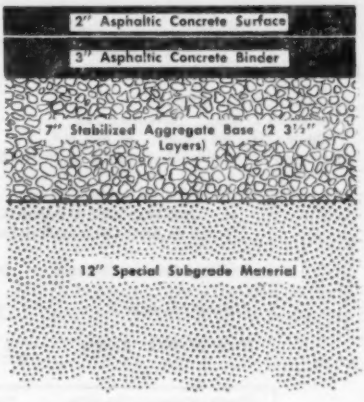
THE TURNER (OKLAHOMA) TURNPIKE

Length: 88 miles
Opened to Traffic: May 1953
Vehicles Carried (through May 16, 1956): 5, 983, 758
Designed for Single Axle Loadings up to 28, 800 pounds

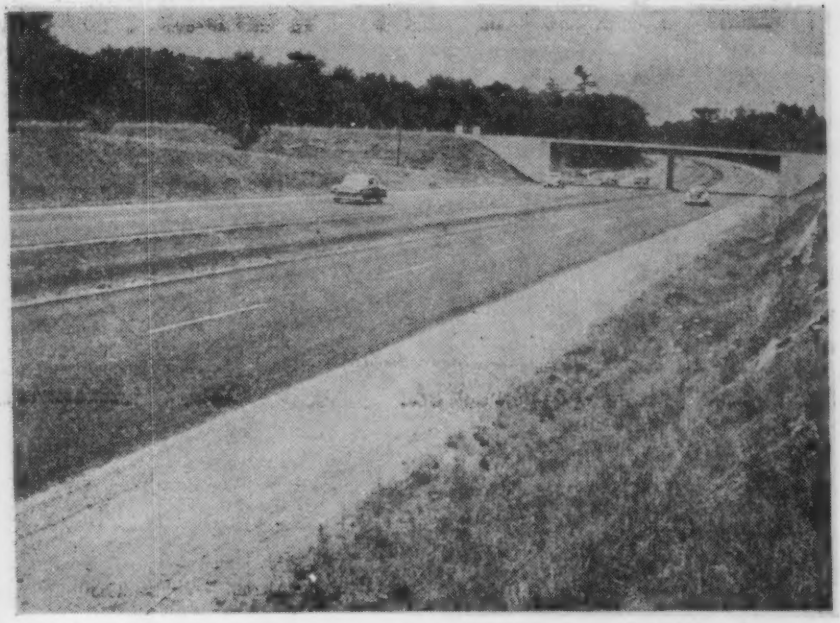
INITIAL COST COMPARISON
Based on Actual Competitive Bid Prices on 82.58 miles

Portland Cement Concrete	---$10, 452, 484
Asphaltic Concrete	--- 9, 291, 364
Total ASPHALT Saving	--- $ 1, 161, 120

ASPHALT Saving Per Mile --- $ 14, 060


2" Asphaltic Concrete Surface
3" Asphaltic Concrete Binder
7" Stabilized Aggregate Base (2 3½" Layers)
12" Special Subgrade Material

NEW HAMPSHIRE TURNPIKE

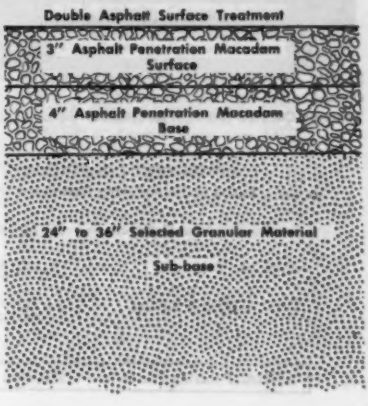


THE NEW HAMPSHIRE TURNPIKE

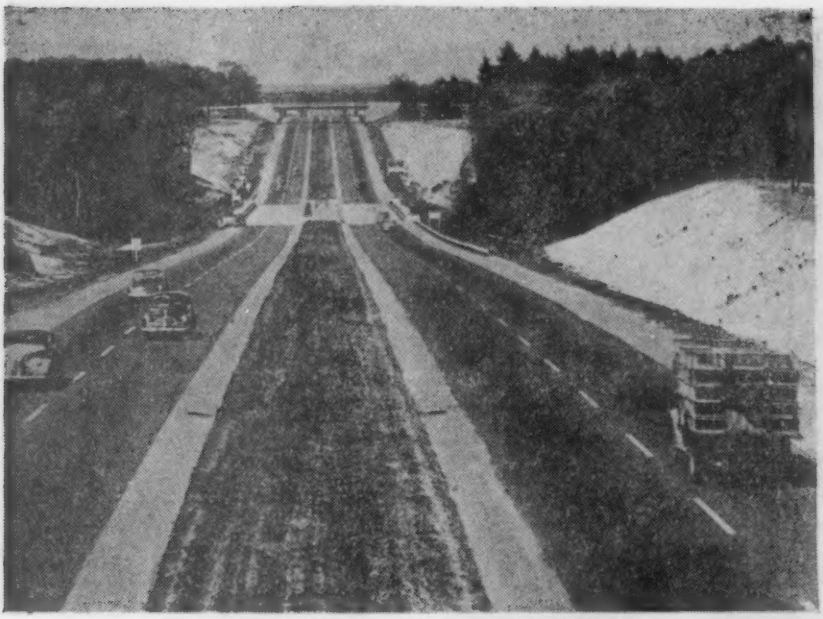
Length: 14.7 miles
Opened to Traffic: June 1950
Vehicles Carried (through May 1955): 14,500,000

INITIAL COST COMPARISON
Based on Actual Competitive Bid Prices

Portland Cement Concrete	---	$6,474,809.50
Asphaltic Concrete	---	5,233,675.50
Total ASPHALT Saving	---	$1,241,134.00
ASPHALT Saving Per Mile	---	$84,430.90


Double Asphalt Surface Treatment
3" Asphalt Penetration Macadam Surface
4" Asphalt Penetration Macadam Base
24" to 36" Selected Granular Material Sub-base

MAINE TURNPIKE



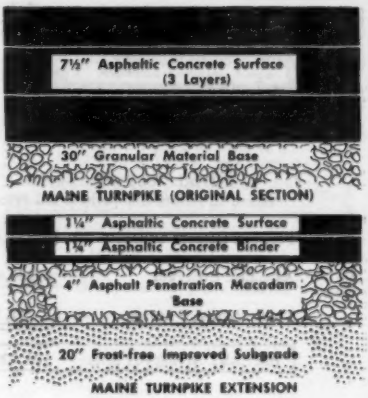
THE MAINE TURNPIKE

Length: 47 miles (66-mile extension added in 1954-55)
Opened to Traffic: December 1947
Vehicles Carried (through December 1955): 17,296,000

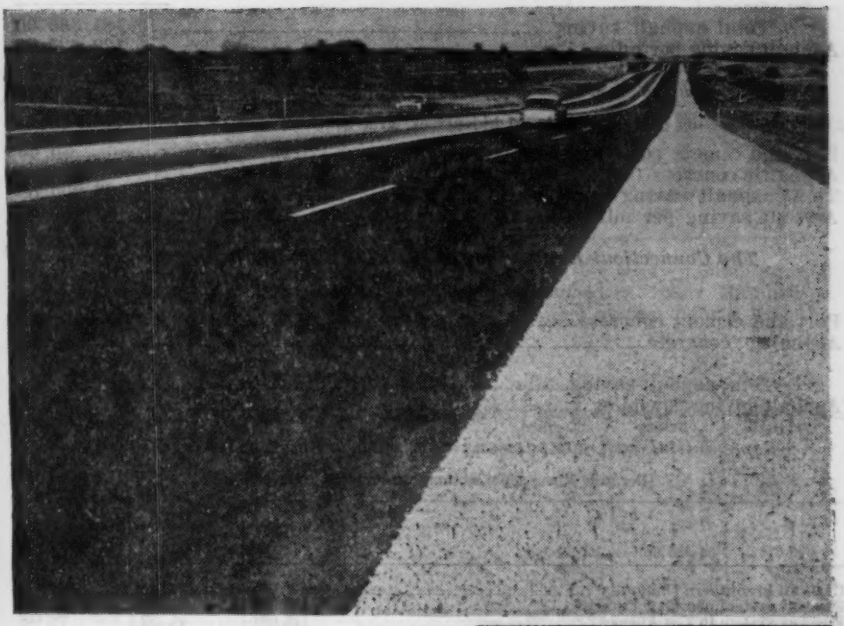
INITIAL COST COMPARISON
Based on Engineering Estimates

Portland Cement Concrete	---	$5,785,369
Asphaltic Concrete	---	4,812,624
Total ASPHALT Saving	---	$ 972,745

ASPHALT Saving Per Mile--- $20,696.70



KANSAS TURNPIKE

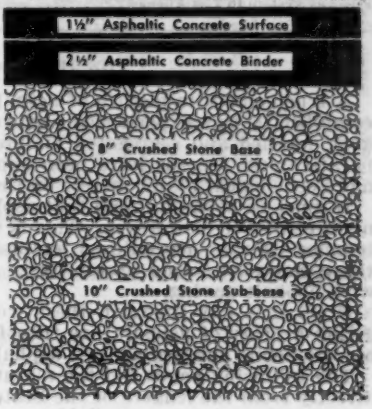


THE KANSAS TURNPIKE

Length: 234 miles (181 miles asphalt pavement)
Opened to Traffic: October 1956
Designed to Carry Single Axle Loadings up to 36,000 pounds

INITIAL COST COMPARISON
Based on Engineering Estimate for Full Length

Portland Cement Concrete	---	$47,196,878
Asphaltic Concrete	---	44,442,950
ASPHALT Saving	---	$ 2,753,928



SOME INITIAL COST COMPARISONS OF ASPHALT-PAVED TURNPIKES UNDER CONSTRUCTION

The Massachusetts Turnpike (123 miles)

[Based on engineering estimate]

Portland cement concrete	$25,636,600.00
Asphaltic concrete	10,455,265.00
Total asphalt saving	15,181,335.00
Asphalt saving per mile	123,425.40

The Richmond-Petersburg, Va., Turnpike (36 miles)

[Actual bid prices, first section]

Portland cement concrete (square yards)	$5.65
Asphaltic concrete (square yards)	4.02
Total asphalt saving (projected)	2,065,200.00
Asphalt saving per mile	50,700.00

The Connecticut Expressway (130 miles, 60 miles to be asphalt)

[Actual bid prices, first 3-mile section]

Portland cement concrete	$5,006,411
Asphaltic concrete	4,728,527
Total asphalt saving	277,884
Asphalt saving per mile	92,628

Some initial cost comparisons on California heavy-duty highways

[Per mile where some sections are concrete, some asphalt]

	Concrete	Asphalt	Asphalt saving per mile
U. S. 101 in southern California	$117,990	$72,371	$45,619
Freeway system near San Francisco	143,616	76,877	66,739
Freeway system in Los Angeles	125,030	46,182	78,848

THE TRUTH ABOUT MAINTENANCE

A true composite picture of actual pavement maintenance costs is not easy to establish, as any experienced highway engineer will confirm. Few States have kept detailed and segregated maintenance cost records. However, where comparative cost records have been kept, asphalt pavements most often prove out more economical than concrete on the maintenance balance sheet.

It must be borne in mind that asphalt pavements, once laid down, are asphalt maintenance items forever. This is not true of rigid concrete pavements. Maintenance charges are entered against these pavements only until such time as these charges become prohibitive. At that point, concrete usually is overlaid with asphalt paving.

From that day forward, these wornout concrete pavements, hidden beneath a thin overlay of asphalt, are transferred to the asphalt side of the ledger and become debits charged against asphalt maintenance.

The following pages tell the maintenance story in cold, hard statistics, taken directly from the ledgers of the State highway departments wherever and whenever they have become available.

THE BAILEY REPORT

The only comprehensive and authoritative study of pavement maintenance costs was the one made by Mr. H. E. Bailey, general manager of the Oklahoma Turnpike Authority, in 1951. Bailey's report included cost data from 15 State highway departments known to keep coherent maintenance cost records. Ten of these States submitted comparative cost data for both types of pavement. Here, in brief tabular form, is the essence of the report compiled by Bailey, whose

conclusion was that maintenance costs should be considered equal for the various pavement designs that were developed for the Turner (Oklahoma) Turnpike:

State reporting	Year covered by report	Average maintenance cost for asphaltic concrete per mile, per year	Average maintenance cost for portland cement concrete per mile, per year
California	1946 to 1950, inclusive	$158.00	$261.00
Indiana	1949	167.21	137.72
Kansas	1946, 1948, 1949	397.58	607.11
Maine	1942 to 1950, inclusive	145.38	219.45
Massachusetts	1940, 1941, 1945	117.73	164.77
New Hampshire	1948, 1949, 1950	78.77	140.58
Oregon	1946 to 1951, inclusive	586.00	408.00
Pennsylvania	1939 to 1942 and 1947 to 1950, inclusive	142.56	192.99
Rhode Island	1948	320.06	137.84
Texas	1945 to 1949, inclusive	106.72	153.76

In some instances, States reporting in the original Bailey study publish annual reports which clearly identify pavement maintenance costs. New Hampshire is such a State. Here are the New Hampshire primary system figures brought up to date:

New Hampshire

	Cement concrete	Modified asphalt	Bituminous macadam
1951:			
Total cost	$26,549.23	$3,238.89	$25,187.20
Miles	251.91	51.01	226.36
Cost per mile	$105.39	$63.50	$111.26
1952:			
Total cost	$40,551.94	$8,080.36	$36,170.64
Miles	239.96	44.77	236.60
Cost per mile	$168.99	$180.48	$157.10
1953:			
Total cost	$33,812.33	$4,383.10	$26,870.78
Miles	215.24	75.27	253.09
Cost per mile	$157.09	$58.23	$106.37
1954:			
Total cost	$26,792.17	$2,671.57	$25,438.35
Miles	209.18	92.36	277.73
Cost per mile	$128.08	$28.92	$91.59
1955:			
Total cost	$33,535.69	$6,670.47	$26,876.95
Miles	207.25	89.34	310.38
Cost per mile	$161.91	$75.79	$86.59

Pennsylvania

Since publication of the Bailey report, an impartial engineering survey has reported the average annual maintenance costs in Pennsylvania during the 1950–54 period as follows:

	Per mile
Portland cement concrete	$454.96
Heavy-duty asphalt	223.99

Texas (Texas Highway Department base and surface maintenance costs of flexible and rigid-type pavements)

Fiscal year ending August 31	Hot-mix asphalt on flexible base		Portland cement concrete (+5 sx. mix)		Portland cement concrete (−5 sx. mix)	
	Average miles	Average cost per mile	Average miles	Average cost per mile	Average miles	Average cost per mile
1937	137.21	$84.37	4,394.51	$41.63	82.06	$87.74
1938	151.66	45.62	4,681.89	41.83	79.13	111.86
1939	272.04	76.27	4,885.24	50.18	186.67	125.94
1940	280.79	64.65	4,979.62	63.21	223.70	90.21
1941	286.29	122.51	5,046.43	59.75	250.18	131.02
1942	286.89	75.57	5,137.44	66.26	256.86	103.25
1943		102.91		81.07		111.90
1944		129.89		102.34		130.04
1945	521.42	93.38	5,116.15	119.95	286.29	167.83
1946	654.16	59.41	5,149.53	129.12	281.59	116.06
1947	723.96	70.21	5,123.46	149.13	278.53	134.13
1948	834.27	127.09	4,872.10	154.13	252.55	144.03
1949	969.66	183.71	4,703.83	216.50	245.09	264.42
13-year average		95.05		98.08		132.19

Source: From Texas Highway Department Biennial Reports No. 11 through No. 20, Sept. 1, 1936, to Aug 31 1956.

Year	Asphalt surface on flexible base		P. C. concrete	
	Average miles	Average cost per mile	Average miles	Average cost per mile
1950 [1]	4,417.48	$255.20	4,822.75	$239.15
1951	4,380.54	235.19	4,701.74	243.81
1952	4,363.18	260.96	4,453.75	333.04
1953	4,474.05	228.96	4,153.68	272.39
1954	4,528.43	237.36	3,734.14	267.64
1955	4,936.54	243.04	3,397.63	311.55
1956	5,313.81	243.81	3,137.37	270.71
7-year average		243.50		276.90

[1] From 1937 to 1949, hot-mix hot-laid asphaltic concrete on flexible base was listed as a separate type of pavement and p. c. concrete was listed under 2 classifications; however, beginning in 1950 a number of types of asphalt surfaces were placed in a single classification and the 2 types of p. c. pavements were combined. For the past several years asphalt surface, 1 inch or more in thickness, on flexible base has included the following types of surfaces: Bituminous road mix, asphaltic macadam, rock asphalt, cold-mix asphaltic concrete and hot-mix asphaltic concrete.

Some representative annual maintenance costs [1]

[Per mile]

WASHINGTON, 1954

	Pavement type		
	Concrete	Heavy-duty asphalt	Other asphalt
Miles	314.5	74.06	1,202.12
Total cost	$63,229.00	$13,255.00	$231,417.00
Cost per mile	$201.00	$178.98	$192.52

MISSISSIPPI, 1952-53

	Pavement type		
	Concrete	Asphalt	Surface treated
Miles	2,075.9	1,660	1,754.8
Cost per mile	$670.33	$545.03	$540.62

LOUISIANA, 1952-53

Miles	2,735	4,451	
Cost per mile	$1,360.59	$784.22	

OHIO, 1952-53

Miles	1,907	11,687	
Cost per mile	$515.00	$359.00	

NEW YORK, 1953 [2]

Miles	5,494	7,067	
Cost per mile	$407.20	$257.60	

[1] State highway department figures except where indicated.
[2] Based on independent engineering study.

IN CONCLUSION

This recital of statistics would indicate that modern asphalt pavements actually cost less to maintain. However, that it not our thesis. We stated earlier that there is documentary evidence to support our assertion that asphalt costs less to build, and costs no more to maintain.

We will rest our case on the foregoing figures, and the following quotation, taken unabridged from the Pavement Design report prepared for the Kansas Turnpike Authority by the eminent firm of consulting engineers, Howard, Needles, Tammen and Bergendoff:

"The types of pavement recommended in this report are comparable only to those designed for other major turnpikes since World War II. The oldest of these pavements have been in use for a period of about 3 to 7 years. Experience to date with these superior pavements is not sufficient to permit an intelligent comparison of maintenance costs and there is no accurate method of estimating any difference that might exist. The most outstanding feature of maintenance on the major turnpikes has been that it has been very small and substantially below the estimate for both types of pavement. It is entirely possible that maintenance costs will not be in favor of either type (e. g., the cost of replacement of localized areas of rigid pavement will be more expensive but less frequent than that required for flexible pavement) * * *."

EXHIBIT B–2

In a paper delivered at the Headquarters, United States Air Force Pavement Maintenance Conference at Colorado Springs, Colo., in May 1956, the following table of average paving costs was offered by Mr. Earle C. Peck, supervising civil engineer, Headquarters, Technical Training Air Force, United States Air Force:

Rigid pavement

	Average cost
Heavy-duty (7,573,000 square yards)	$7.05
Light-duty (1,948,000 square yards)	5.26
Difference, 34 percent or	1.79

Flexible pavement

	Average cost
Heavy-duty (3,340,000 square yards)	$3.76
Light-duty (3,093,000 square yards)	3.30
Difference, 14 percent or	.46

Mr. Peck then goes on to say:

"These unit prices, of course, are low in comparison with the latest United States Air Force pricing guide which shows 17 inches portland cement at $10.50 per square yard, and 10 inches at $8.50 per square yard—a difference of 23½ percent; and bituminous concrete at $6.50 and $5.50—a difference of 18 percent between heavy- and light-duty pavements * * *."

EXHIBIT B–3

OFFICE OF AIRPORT CONSULTANT,
Chicago, Ill., March 25, 1955.

To the Honorable Chairman and Members of the Subcommittee on Aviation of the Finance Committee of the City Council.

GENTLEMEN: In reference to the bids received by the city for the construction of the new runway at O'Hare Field, I have recently submitted through the purchasing agent a recommendation to the finance committee that an award be made to the lowest bidder under the lowest of the two alternate proposals.

At the last meeting of the finance committee the Airline Pilots Association presented a report favoring the use of concrete rather than asphalt for the construction of the main portion of the runway and for that reason the matter was referred for further consideration by your subcommittee.

Specifications provided that bids were to be received on two separate alternates—No. 1, the entire work, including connecting taxiways, bleed-off and parallel taxiways and the main runway to be constructed of a "rigid" concrete pavement; No. 2, the connecting taxiways and the first 500 feet of the runway to be constructed of "rigid" concrete pavement, the balance of the runways and the bleed-off and parallel taxiways to be constructed of a "flexible" type pavement consisting of a macadam base with an asphaltic concrete top. The low bid received for the all "rigid" pavement was $2,046,546.80, the low bid for the combination of part "rigid" and part "flexible" pavement was $1,304,550. Since the total amount tentatively allocated by the Government for this and other work is $1,665,000, it is obvious that if we are to construct the runway we will of necessity have to accept the lower of the two alternates.

The two types of pavement are of equal length, width and strength and under CAA requirements they insist that Federal funds only be spent for the lower of the two alternates.

The Airline Pilots Association advance the following reasons for their preference for concrete pavement:

A. Concrete is more quickly visible to the approaching aircraft than the asphalt. This, of course, will be cured by painted strips on the asphalt runway which will give it equal or greater prominence from the air than the concrete runway. The objection is also answered by the proposed installation of "high intensity" runway lighting which clearly defines the runway even under low visibility conditions.

B. They fear the effect of the operation of jet aircraft on asphalt pavement for two reasons—first, the spillage of fuel during any warmup or waiting period

might disintegrate the asphalt and, second, the effect of the blast from the jet engine would melt the asphalt.

In this regard the purpose of making the connecting taxiways and the first 500 feet of runway of concrete was to guard against the spillage of fuel disintegrating the asphalt at the critical time of waiting and warming up. The effect of jet blast is also more critical while the jet planes are standing and warming up rather than on the main runway, which is an additional reason for providing concrete for these critical areas.

The most authentic findings on this subject are contained in the Report of the Subcommittee on Defense Activities of the Committee on Armed Services of the United States House of Representatives, dated May 21, 1954. In the public hearings upon which this report is based testimony was given by the Department of the Air Force, the Bureau of Yards and Docks of the Navy Department, the Asphalt Institute, and the Portland Cement Association. In this discussion the Air Force requested that a difference of 5 percent in cost in favor of concrete be established. The Navy, however, does not allow a price premium for either. After reviewing the data presented by the various groups, the following findings of the committee were summarized:

The effective blast from jet engine is minor in character.

The maintenance costs are in fact about equal for both asphalt and concrete.

The great hazard in operating jet aircraft is loose material or debris which damages tires, gets into the airstream, and can be sucked into the jet pods damaging or ruining the blades. However, they find that neither asphalt nor concrete excludes this hazard. The conclusion of this committee is as follows:

"It is our opinion, after considering all factors, that the continuation of concrete in critical areas as a design criteria is justified; and it is our opinion, from all the evidence, that cost in the noncritical areas between concrete and asphalt should be weighed without a price differential and by a direct comparison of first costs."

The Civil Aeronautics Administration through whom the Government is furnishing the funds for the construction of this runway adopt the same ruling, namely, that asphalt can be considered as a full equivalent of concrete for runways outside of the critical areas above mentioned, in which areas we are specifying the use of concrete.

At the major airports throughout the country, the principal runways are predominantly of asphalt. From CAA records the following are of asphalt: Boston-Logan Airport, LaGuardia, Newark, Philadelphia, International, Baltimore-Friendship Airport, Miami-International, Nashville, Pittsburgh, Denver, Stapleton Field, Phoenix, Los Angeles International, San Francisco, and Portland. The following are of concrete: Idlewild, Atlanta, Wayne County, Minneapolis, Kansas City Municipal, St. Louis, Fort Worth, and Seattle. In many instances, as at New Orleans, Columbus, and Minneapolis, old concrete runways have been covered with asphalt overlays.

The most recent and immediate example of runway construction is at O'Hare Field. The United States Government recently lengthened the existing northwest-southeast concrete runway by adding at both ends a total of about 2,000 feet of asphalt runway for jet aircraft operation.

Under all the circumstances and particularly because of the saving to the city of over $700,000, I can see no alternate for the city to follow but to accept the lowest alternate for the construction of the runway.

Respectfully submitted.

RALPH H. BURKE,
Airport Consultant, City of Chicago.

EXHIBIT B–4

"* * * In our letter of September 2, 1952, it was stated that in the prior 18 months the division between asphalt and concrete had been 60–40 and the dollar cost of the two types had been approximately the same. What was meant was that the ratio of the quantity of asphalt pavement to concrete pavement, for which awards were made, was 60-40. The total cost of the asphalt pavement was approximately equal to the total cost for the concrete which means that on a unit basis the cost of concrete is approximately one and one-half times the cost of asphalt. More recent figures received from our major construction agent reveal that from January 1, 1951, to October 30, 1952, contract awards were made on a total of 21,098,549 square yards of pavement of which 53 percent were for asphalt and 47 percent were for concrete.

"On the matter of maintenance costs the records of worldwide average expenditures do not indicate any significant cost differential per square yard between the two types of pavement. It must be stated, however, that to date only a small percent of our active aircraft is jet propelled. By fiscal year 1957, it is anticipated that 50 percent of the active aircraft will be jet propelled. Jet-propelled aircraft impose two potentials for airfield pavement damage not imposed by conventional aircraft. One potential is jet blast, with its high temperatures and velocity. The second is spillage of raw jet fuel on the asphaltic parking areas during fueling, and other ground operation periods. This spilled fuel, while not incompatible with portland cement concrete has a most harmful potential where asphalt is concerned because of the solubility of asphalt in petroleum derivatives.

"From the standpoint of ground handling of aircraft, no difficulties have been encountered. Either portland cement concrete or high quality asphaltic concrete or a combination of the two has proven generally acceptable to the Air Force * * *" (from letter of July 6, 1953, from Robert E. L. Eaton, major general, USAF, director, legislative liaison, to Hon. William E. Hess, chairman, Subcommittee on Defense Activities Committee on Armed Services, House of Representatives).

SUPPLEMENT TO EXHIBIT B–4

"A tabulation of contract awards by the Corps of Engineers on airfield paving has been made covering a 15-month period between February 1, 1952, and May 1, 1953. This tabulation reflected comparative bid prices of the pavement structure alone for portland cement concrete and bituminous concrete and did not include bid items common to both types such as grading, drainage and electrical installations. Copies of the complete tabulations were furnished Col. R. H. Curtin of your headquarters and to the Engineering Branch of your Architectural and Engineering Division in June 1953. A summary of the tabulation also furnished your headquarters, discloses that on a nationwide average, the rigid type pavement (portland cement concrete) costs 83 percent more for heavy duty pavements and 90 percent more for light duty pavements than for the equivalent pavements in the flexible type (bituminous)." (David H. Tulley, brigadier general, United States Army, Assistant Chief of Engineers for Construction, official memorandum to Chief of Staff, USAF (attention: Director of Installations), dated October 16, 1953).

EXHIBIT C–1

ASPHALT
Paves Seven of Nation's Ten Leading Airports

Modern asphalt pavement has posted an enviable record in the construction of streets, highways and airfields. Its mileage leadership on the nation's roads is indisputable, as U.S. Bureau of Public Roads statistics attest, year after year. A glance at the chart on page two of this magazine will reveal that state highway departments annually build more asphalt pavement, both heavy-duty and low-cost, than any other kind.

There are, of course, good reasons for this. First, heavy-duty asphalt pavement is a truly modern pavement, the only really up-to-date pavement available to engineers for constructing the modern highways today's heavy traffic requires. It is smoother than any other pavement. It is stronger. It is easier, faster and far less costly to construct. Maintenance is low cost—certainly no more than for other pavement types—and can be accomplished with much greater speed and facility.

A second major reason why engineers overwhelmingly prefer asphalt pavement is its versatility. It is this quality, inherent in asphaltic materials, which makes asphalt paving the only practical means for improving old, obsolete roads regardless of the type of existing pavement. In other words, it can not only economically rejuvenate, strengthen and widen old asphalt roads showing distress under traffic they were never designed to carry, but it can also be used to salvage deteriorating slab-type highways by economical undersealing, widening and resurfacing.

ASPHALT LEADS IN AIRFIELD PAVING

In airfield paving as in road construction, asphalt holds a commanding lead. Its preference by airport officials and engineers stems from proven performance based on the advantages cited above. With air traffic continually increasing (CAA statistics for 1956 show a 9% increase in total operations over 1955 and an incredible 54% over 1951) and the commercial airlines putting into service bigger, heavier and faster planes, many major civil airports have not only enlarged their field area and passenger facilities but have also scheduled programs for improvement and strengthening of runways and taxiways rapidly becoming obsolete. Almost without exception airfield engineers have picked asphalt paving to accomplish the latter task.

Obviously, the need to perform airfield pavement stage construction and maintenance with dispatch is a vital one. A runway or taxiway put out of commission for repairs even for a few days could seriously disrupt the efficiency of airport traffic operations. With asphalt paving, maintenance repairs and improvements can be carried out rapidly and easily—day and night—from minor patching to total resurfacing. Once the new paving is placed, the airstrip can be opened to traffic within a few hours, since no long curing period is required.

WARTIME PAVING PROVIDES PROOF

This important advantage of asphalt paving—speed and ease of construction and maintenance—was put to the test and fully proven at many of our military airbases built during World War II in captured enemy territory in the Pacific and China-Burma-India Theatres. With speed of the essence in establishing these outposts for safe, efficient landings and takeoffs by U.S. fighters and bombers, Army and Navy construction battalions paved the runways with asphalt that had been barreled and sometimes flown to the site by transport planes. Often employing thousands of native laborers, these tremendous surfacing projects, providing smooth, durable all-weather runway pavements, were performed and placed in service in a matter of days. Only with asphalt could the job have been done in so short a time.

SUPERIOR IN ALL RESPECTS

Asphalt paving has long played a significant role in the evolution and development of aviation. When the grass landing strip became obsolete under the loads of bigger, heavier planes, asphalt provided the economical hard-surfaced pavement they demanded. It has been an indispensable part of the airfield paving picture ever since. So highly regarded are its superior qualities of smoothness, durability and long life, its economy of construction and maintenance, and its extreme utility in strengthening and improving old airfield pavements of any type, that **seven of the ten leading civil airfields in the United States with respect to number of takeoffs and landings are asphalt paved.**

The following pages describe these seven fine airports, all of which daily play host to hundreds of our most modern commercial aircraft. Airport engineers can take pride in the knowledge that the heavy-duty asphalt pavement is as modern as the aircraft it serves.

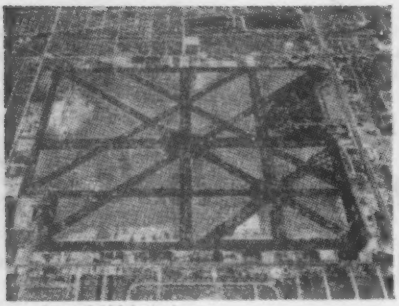


Photo: Chicago Aerial Industries, Inc.

CHICAGO MIDWAY AIRPORT

Chicago Midway is the busiest airport in the United States. During fiscal year 1956, according to the Civil Aeronautics Administration, the number of aircraft operations excluding purely local flights amounted to 366,079, exceeding by over 100,000 the number of takeoffs and landings recorded at the second-ranking airport, New York's LaGuardia. Since 1927, when Midway was opened, the number of plane movements has totalled well over 4,500,000. During its 28-year life the airport has served nearly 67 million passengers.

To handle increasing traffic volumes and aircraft weights through the years, Midway engineers have effected a number of programs of expansion and improvement of facilities. In April 1941, the field was doubled in area by linking its north and south halves. This increased the length of all taxiways and runways, the longest of which is now 6410 feet overall, for greater safety and maneuverability.

Although periodic asphalt stage construction has been carried out for many years at Midway to accommodate additional plane weights and landing weights as required for operations, the first major resurfacing program went into effect in 1948 when approximately 133,000 tons of heavy-duty asphalt pavement were applied to all eight taxiways and runways. Additional thickening and strengthening of runways with asphalt has occurred during the period 1948 to 1956 at the rate of approximately 4000 tons a year.

This year, 1957, airport authorities are overlaying two taxiways with 2½" of asphalt hot-mix, increasing their load-bearing capacity to accommodate the new, heavier DC-7's and turbo-props.

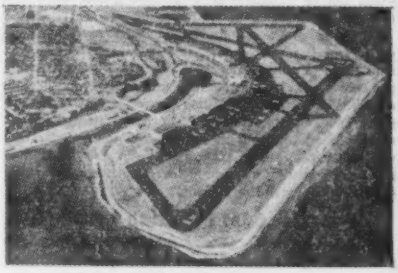
NEW YORK's LAGUARDIA AIRPORT

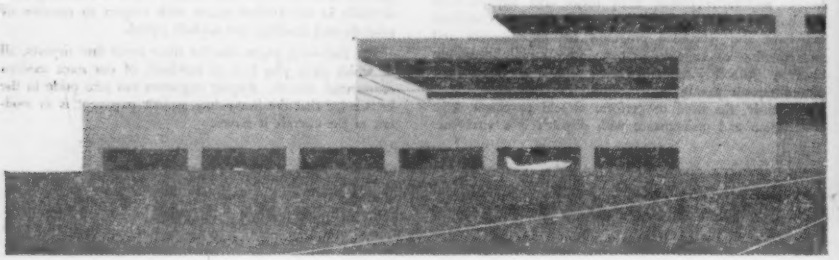
The nation's second busiest civil airfield is LaGuardia Airport, located at the entrance of Flushing Bay in the Borough of Queens, New York City. Criss-crossing the field are four asphalt runways, one of which is closed to flight operations.

The Flushing Bay area is noted for the unstable nature of its subgrade soils, a condition which dictated use of a flexible surfacing material at LaGuardia. The inherent flexibility and resiliency of asphalt paving is one of its chief advantages, one that enables it to "give" when the earth beneath it subsides. This feature contrasts with the brittleness of rigid pavement which bridges over depressed areas in the subgrade and eventually, under pounding by traffic, cracks and breaks up. When this occurs the only solution is to underseal the slabs with liquid asphalt and resurface them with heavy-duty asphalt pavement. LaGuardia's engineers, therefore, decided to build the runways with asphalt in the first place. They completed the project in 1936.

The extreme settling condition at LaGuardia, coupled with tremendous step-ups in aircraft operations and increased aircraft loads, have prompted airport engineers to perform extensive resurfacing operations over the years. Asphalt, of course, has been used in all improvements, thickening the runways for increased strength. Pounded by the tremendous loads of over 260,000 aircraft in 1956, LaGuardia's asphalt pavements are adequately carrying the world's biggest and heaviest commercial planes.

Photo: Fairchild Aerial Surveys





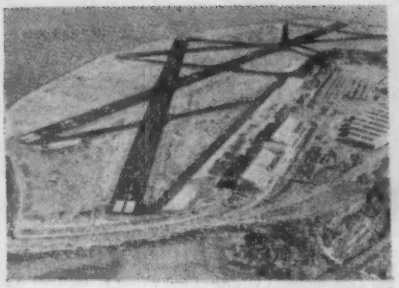


Photo: Fairchild Aerial Surveys

WASHINGTON NATIONAL AIRPORT

Located at Gravelly Point, Virginia, on the west bank of the Potomac River five miles south of the nation's capital, is Washington National Airport. The field was built approximately sixteen years ago on hydraulic fill excavated from the river. Its four asphalt runways served some 237,000 aircraft in 1956.

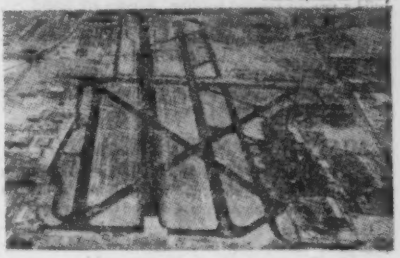
The runways consist of 1½" of asphaltic concrete surface over a 2" asphaltic concrete base. A sub-base of mechanically stabilized sand-gravel supports these pavement layers. This relatively thin structure is one of the reasons for asphalt's much lower initial construction cost. And to prove that economical asphalt surfaces are low in maintenance cost, one need only regard the performance of the pavements at National Airport. Subjected every day to the loadings of commercial aircraft weighing several hundred thousand pounds, National's runways have required only minor repair and sealing during their lifetime.

L.A. INTERNATIONAL AIRPORT

Thirty years ago Los Angeles International Airport was a bean field. Today it is the fourth largest commercial airport in volume of air traffic in the United States. Its airplane movements in 1956 numbered 228,917.

The development of this great air terminal reflects the growth of commercial aviation in our nation. In 1925, the airport boasted only a single 2,200-foot macadam strip. Then in 1938 and 1939 the City of Los Angeles, which owned the field, built two heavy-duty asphalt runways to accommodate increasing traffic. These provided excellent service with practically no maintenance for twelve years. So extensive were the changes and developments that took place in aircraft production and design during this period that additional runways, extensions and improvements to increase load-bearing capacity were undertaken between 1948 and 1951, with most of the pavements built over an emulsified asphalt stabilized base. Since then, periodic strengthening with asphalt and extension of taxiways have been conducted to streamline operations while traffic volumes and aircraft weights continue to rise.

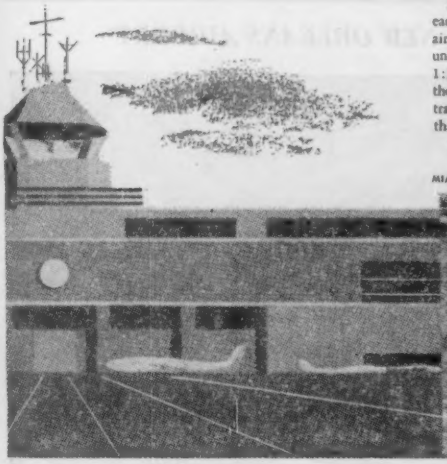
Photo: Spence Air Photos



ATLANTA MUNICIPAL AIRPORT

Handling more than three hundred scheduled airline flights each day, Atlanta Municipal Airport ranks fifth among asphalt airports in volume of plane movements. It also holds a record unique among all commercial airfields: between 12:30 and 1:30 each day, Atlanta conducts the busiest single air hour in the nation. In other words, although other cities have more traffic during a day, Atlanta handles more during that hour than any other city during any other hour.

The airport has four runways, three of which are surfaced



MIAMI INTERNATIONAL AIRPORT *Photo: Fairchild Aerial Surveys*

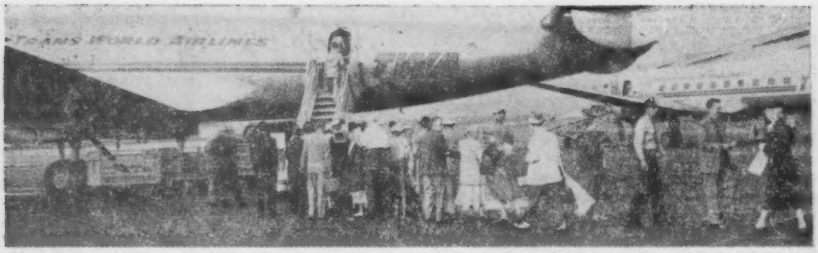


Photo: Trans-World Airlines

with modern asphalt pavement. In 1956 they served 188,467 planes. Moreover, most of the taxiways and all of the apron area are paved with asphalt.

Municipal airport authorities, in addition to conducting a program of new taxiway construction with asphalt pavement, part of which is now under contract, are planning to request Atlanta taxpayers for approximately $12 million to build a new air terminal building. If plans are carried out, the new terminal would considerably increase the airport's capacity, not only easing the handling of passengers but providing parking space for at least 100 of the largest type planes in use to date.

Atlanta is an excellent asphalt field destined to become one of the world's finest.

MIAMI INTERNATIONAL AIRPORT

Sixth on the list of major asphalt-paved civil airfields is Miami International Airport, the nation's foremost hub for travel to Mexico, South America, Cuba and the West Indies.

Last year over 183,000 planes used its four rugged asphalt-paved runways that have long afforded smooth landings, take-offs and taxiing for the big trans- and inter-continental airliners annually carrying thousands of European, U.S. and Latin American vacationers and visitors to and from our shores.

ALBUQUERQUE AIRPORT

The Albuquerque Airport is known officially as Kirtland Air Force Base. It is open, however, for public transportation, and three commercial airlines make use of its facilities. The airport's control tower reported nearly 179,000 takeoffs and landings in 1956.

There are five runways at Albuquerque, the newest one, running east-west, having been constructed in 1954 and 1955 by the U.S. Army Corps of Engineers. The entire stretch, with the exception of 500 feet at either end is paved with 4" of asphalt hot-mix. Total thickness of the pavement structure varies from a minimum of 12" to a maximum of 17". Base material is composed of sand and crushed gravel.

Most of the other runway and taxiway pavements were built just prior to and at the beginning of World War II with WPA funds. Except for certain small areas of slab pavement, principally at runway ends and warm-up areas, the construction is all modern asphalt pavement.

RUNWAY RENEWED AT NEW ORLEANS AIRPORT

This striking photo gives a bird's eye view of the east-west runway at New Orleans' Moisant Airport. As part of a five-year, multi-million-dollar modernization plan, engineers for the city's aviation Commission in September 1955 used modern, heavy-duty asphalt pavement to rejuvenate and strengthen the worn-out slab pavement built only eleven years earlier. Note the sharp delineation of pavement markings against the smooth, dark asphalt.

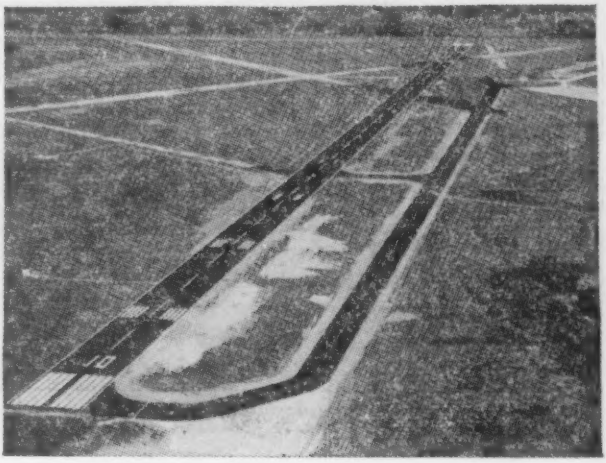


Photo: Gerr Studio

EXHIBIT C-2

Although they have very high cruising speeds, the new jets will be able to approach and land at speeds not much above those of present transports. There has been a great deal of concern about runway lengths. True, the jets will require long runways for transocean flights. But we expect most jet flights to follow much the same pattern as present-day transports. That means that the bulk of jet flights will be over moderate distances. Taking off with fuel tanks only partly full, the jet transport can accommodate itself to the runways now existing at the larger municipal airports. * * *

Every airport manager is interested in the effect of the heavy jets on his runway paving and the paving of his taxiways and runup pads. It may be necessary to add to the paving thickness at some airports, particularly if the jet transports are heavily loaded. However, the wheels of the new aircraft are widely spaced so that they spread the weight over large areas of pavement and the runway problem, from a load-bearing standpoint, does not appear to present us with any immediate crisis.

The effect of jet blast and spilled fuel on paving is something which we are investigating carefully since we are deeply concerned with both new and existing construction. From what we have learned to date, it does not appear that either the blast or an occasional bit of spillage is going to do any great amount of damage. (Airports in the Jet Age, address by James T. Pyle, Administrator Civil Aeronautics Administration, at the Jet Age Conference of the Spokane Wing of the Air Force Association, Spokane, Wash., September 14, 1956.)

EXHIBIT C-3

The Periscope

Washington Trends

Diplomat's Entrance Exams

Even before he gets to Washington, Gov. Christian Herter of Massachusetts is the capital's new leading man-in-the-middle.

The new Under Secretary of State is caught in the cross fire of pro- and anti-British members of the Administration.

The British have been wooing Herter openly—much to his embarrassment, since his new boss, Secretary of State John Foster Dulles, is still rankled at the British over Suez.

As a consequence, Herter has taken a diplomatic out: To see no diplomats or newspapermen until the controversy dies down.

Fortress America

Gen. Curtis LeMay, chief of the Strategic Air Command, fears an all-out atomic attack could destroy all our B-52 bases within a few hours.

Only two U.S. fields—at Merced, Calif., and Limestone, Maine—are properly equipped to handle the huge intercontinental bombers. Other bases are in England, North Africa, Guam.

LeMay wants alternate bases built, both in the U.S. and abroad—fast.

Despite claims that the B-52 is fast flying into obsolescence, the Air Force is not freezing its design. In fact, improvements are now being made to make it higher, faster, a poorer target.

Strategic Air Command brass believes the B-52 will give the U.S. good retaliatory protection for five years. By then, they hope, the intercontinental guided missile should be perfected.

The New South

Herman Talmadge, Georgia's new senator, will almost completely reverse the position of his predecessor, Walter F. George, on foreign aid. George, now President Eisenhower's special representative to NATO, was a steadfast supporter of the Marshall plan and other forms of mutual assistance among nations.

Talmadge says he will oppose spending U.S. funds for "all manner of doubtful global experimentation throughout the face of the earth." He particularly dislikes overseas agricultural help as long as the United States has farm surpluses.

Talmadge also would like to see Congress reverse the Supreme Court on school segregation.

New Labor Laws

Despite the problems of getting it through Congress, the White House will go all out to revise Taft-Hartley.

Labor Secretary James P. Mitchell, a favorite of President Eisenhower, is getting solid Administration support for the changes in the law that many labor leaders want.

On the White House list for change: A section requiring union heads, but not employers, to take an anti-Communist oath. Labor leaders resent this as a reflection on their patriotism.

Tiff With Israel

Relations between the State Department and the Israel Government are becoming strained.

Israel repeatedly has asked State to define U.S. policy on Gaza and freedom of passage for Israeli ships through Suez, but so far it has received no assurance of support.

U.S.-Israel relations may get worse. The State Department opposes further U.S. aid to Israel until it obeys the U.N. resolution calling for evacuation of all foreign troops from Egypt.

Conservative?

Senate Minority Leader William F. Knowland is losing some support among the more conservative Republicans.

They are disappointed that Knowland, in his role as U.S. representative to the United Nations, has failed to push for a stronger condemnation of Russia's brutality in Hungary.

The conservatives are unappeased by arguments that Knowland's job at the U.N. is to follow U.S. policy, not make it. Some feel he has been "taken in" by the Administration.

For **Business Trends**, *see page 53.*

EXHIBIT C–4

"* * * I have one last observation, and it is probably a good thing that it is the last one, as I am going way out on a limb in making it. It concerns the recent criteria dealing with the construction of primary runways. The criteria states that the pavement will normally be constructed of portland cement concrete with the exceptions considered on request to Headquarters USAF. From this, the observer can only conclude that, if he can afford it, he will be much better off with a portland cement runway. We have under construction at Eglin a 12,000 foot long, 300 foot wide, heavy duty runway, designed for channelized traffic. Warmup aprons and parking aprons, being constructed in conjunction with it, are portland cement which is, in my opinion, the best type pavement for this particular usage. With the exception of 1,000 foot portland cement sections of either end of the runway, however, the runway and taxiway are asphaltic concrete. I am very well satisfied with this arrangement. As far as I have ever seen, asphaltic concrete pavements, subjected to moving traffic only, have held up excellently except in a few cases of improper design or where proper control was not exercised during construction.

"Damage to asphaltic concrete runways from jet-blast effect or fuel spillage is only slight. The few cases of rutting of bituminous concrete pavements in the channelized area from bicycle-type landing gear, along with some surface flushing which has occurred, are the exceptions which can be eliminated by the proper design mix and good control and inspection during construction.

"The problem inherent with rigid-type pavement, of joint maintenance, is eliminated as well as the prospect of being faced with what could be a very costly project in case of failure of the extremely thick slabs now required for channelized traffic. In the event that wheel loads are increased still further in the future, either from in-service loading or aircraft design, the flexible-type pavement will lend itself more readily to strengthening to meet these additional loads, as well as being more economical to repair in cases of pavement failure due to overloading.

"If it is decided to construct runways using a rigid pavement, certain localities, having soils with a low "k" value and aggregates producing a low flexural strength concrete, will have pavement thicknesses in excess of 2 feet in the channelized areas if present design methods are followed. These extremely thick slabs are going to present problems due to internal stresses set up from warping caused by temperature differential of the top and bottom surfaces. To eliminate this problem, as well as to effect a possible economy in construction, the traditional concept of rigid pavements as a slab whose strength is increased by adding to its thickness might well be discarded in favor of reinforced or prestressed sections in the channelized areas" (Mr. Paul T. Sutton, pavements engineer, Air Proving Ground Command, Eglin AFB, Valparaiso, Fla., from paper delivered at Headquarters USAF Pavements Maintenance Conference, Colorado Springs, Colo., May 28–31, 1956).

EXHIBIT C–5

RECOMMENDATIONS

Summarized below are recommendations based upon evaluation and analysis of the committee's findings.

Heat, blast, and fuel spillage

1. From the standpoint of damage due to heat, blast, and fuel spillage from jet planes, pavements of either portland cement or asphaltic concrete are satisfactory and are recommended for use in the central portions of taxiways and runways where planes are moving continuously.

2. Portland-cement concrete should be used for pavement in certain critical areas, such as maintenance and fueling areas, warmup pads, aprons, and on those portions of runways and taxiways where planes are likely to be stationary with the engines running.

3. The extent of critical areas should be based upon the type of field operation, runway and taxiway layout, and economic considerations. The final decision should be based on sound engineering judgment in which all factors, including operational requirements, will be given full consideration.

Selection of pavement type

4. Cost of construction and maintenance should not determine the selection of pavement type in critical areas, since the differences in costs of the two

principal types are not so great that they should take precedence over operational requirements. In noncritical areas, where either portland cement or asphaltic concrete is satisfactory, costs of construction and maintenance should be considered along with operational requirements in a carefully conducted engineering analysis for the selection of pavement type.

Engine damage

5. Better sweeping practices and greater policing of fields by maintenance crews should be employed to reduce the possibility of engine damage due to loose particles. Other practices needed included adequate stabilization of shoulders and service roads; restricting operation of motor vehicles using runways, taxiways, and aprons to paved surfaces; and development of more efficient sweepers (from report of Special Committee, Highway Research Board, studying effects of military aircraft on airfield pavements (1955)).

EXHIBIT C–6

THE ASPHALT INSTITUTE,
PACIFIC COAST DIVISION,
San Francisco 4, Calif., April 18, 1957.

Mr. A. S. WELLBORN,
Chief Engineer, The Asphalt Institute, Asphalt Institute Building, University of Maryland, College Park, Md.

DEAR MR. WELLBORN: Transmitted herewith is the report requested in your letter of March 28, 1957, covering the following five Air Force bases in the Pacific Coast Division:

David-Monthan Air Force Base
March Air Force Base
Castle Air Force Base
Travis Air Force Base
Fairchild Air Force Base

Separate tabulations are presented for each of the above referenced bases in the order given, covering:

Name of field and description of facility and operation;

List of primary use areas paved with asphaltic concrete, portland cement concrete, or tar rubber;

Comparative cost figures where available and specific comments on the performance of the various areas based on personal observation by Division V engineers.

It is our firm belief in Division V that all areas paved with asphaltic concrete are serving very well under current wheel loading, traffic, and operational conditions.

Very truly yours,

B. A. VALLERGA,
Managing Engineer, Pacific Coast Division.

DAVIS-MONTHAN AIR FORCE BASE, TUCSON, ARIZ.

March 27, 1957—Reported by D. G. Evans

1. Davis-Monthan Air Force Base has an asphaltic concrete runway with ends of portland cement concrete. This runway has been adequately serving tactical B–47 aircraft operations in excess of 2 years.

2. The following is a list of primary use areas at Davis-Monthan Air Force Base paved with asphaltic concrete:

Facility	Dimensions	Area
	Feet	*Square yards*
Main runway	11,500 by 200	255,556
Taxiway No. 14	11,500 by 75 [1]	70,278
Taxiway No. 15	800 by 75	6,667
Taxiway No. 16	800 by 75	6,667
Taxiway No. 17	800 by 75	6,667
Taxiway No. 18	800 by 75	6,667
Taxiway No. 19	6,500 by 75	54,166
Taxiway No. 15–A	800 by 75	6,667
Total		413,335

[1] Was asphaltic concrete but repaired with 11,500 feet by 20 feet portland cement concrete down center.

3. The following is a list of primary use areas at Davis-Monthan Air Force Base paved with portland cement concrete:

Facility	Dimensions	Area
		Square yards
Apron		430,025
Taxiway No. 14	11,500 by 20 feet	25,555
Subtotal		455,580
Runway ends	1,000 by 200 feet 300 by 200 feet	28,888
Total		484,468

4. The following is a list of primary use areas at Davis-Monthan Air Force Base paved with tar rubber:

Facility	Dimensions	Area
		Square yards
Apron	635 by 365 feet	25,753
Do	300 by 425 feet	14,167
Taxiway	1,100 by 75 feet	9,166
Total		49,086

(Areas described in items No. 2, 3, and 4 above pertain to primary use areas only. There are many obsolete features at this base that are used for storage that are not listed. Many of these obsolete facilities are so substandard as to be not much more than dust palliatives.)

5. Cost figures for Davis-Monthan Air Force Base were not readily available; therefore, no comparisons have been made.

6. During the inspection of airfields a year ago, it was the opinion of the operating personnel at the base that, while the main runway was satisfactory, it was only a question of time until it failed. Failure has not materialized and, as of March 27, 1957, it is performing satisfactorily under tactical operations of B–47 type aircraft.

During the inspection of the base a year ago, Mr. Marker and Mr. Evans were uncertain as to the service that could be anticipated from a sand seal coat placed on the main runway in the fall of 1955. Fortunately, little or no distress has occurred in this seal coat and, as of now, it is performing satisfactorily.

It was also observed, during the same inspection a year ago, that taxiway No. 14 had a section that showed considerable distress due to the effect of channelized B–47 traffic. It was apparent that the trouble was being caused by the mix, which was unstable. Since that time the center section has been replaced with a 20-foot strip of portland cement concrete, a portion of which is now subject to criticism because of surface roughness. Of the 11,500-foot center section of concrete, 3,000 feet were ground with diamond-tipped tools to improve the smoothness before the project was accepted.

In discussing the condition of the airfield with the Air Installations Office, it was brought out that operations personnel still complained a little bit periodically about the porpoising of their aircraft on takeoff between 3,000 and 6,000 feet from the northwest end of the runway. A level survey on 10-foot centers in both directions has failed to identify any cause or the location of the exact area where this porpoising might occur. It may be that something other than runway smoothness is contributing to this action.

There are no complaints at the present time on this base against either asphaltic concrete or portland cement concrete.

MARCH AIR FORCE BASE, RIVERSIDE, CALIF.

April 8, 1957—Reported by D. G. Evans

1. March Air Force Base has an asphaltic concrete runway. This runway has been adequately serving tactical B–47 aircraft operations in excess of 2 years.

2. The following is a list of primary use areas at March Air Force Base paved with asphaltic concrete:

Facility	Dimensions	Area
		Square yards
Runway 5	10,027 by 200 feet	222,822
Taxiway 2	1,632 by 75 feet	13,600
Taxiway 11	3,933 by 75 feet	32,775
Taxiway 5	360 by 75 feet	3,000
Apron 9	840 by 1,440 feet	134,400
Taxiway 1 (old runway)	5,355 by 150 feet	89,250
Total		495,847

3. The following is a list of primary use areas at March Air Force Base paved with portland cement concrete:

Facility	Dimensions	Area
		Square yards
Aprons 1, 3, 8		261,000
Operational apron	3,112 by 85 feet	29,391
Total		290,391

4. The following are some cost figures extracted from bids taken in 1955 at March Air Force Base:

(*a*) *Structural section.*—15-inch portland cement concrete on rock base. Total cost per square yard of structural section: $5.60 per square yard.

(*b*) *Structural section.*—4-inch asphaltic concrete on 7-inch macadam on 6-inch 65 CBR base on 11 inches of decomposed granite subbase.

Total cost per square yard of structural section: $2.92 per square yard.

CASTLE AIR FORCE BASE, MERCED, CALIF.

April 9, 1957—Reported by Vaughn Marker

1. Castle Air Force Base has an asphaltic concrete runway with the 1,000-foot ends of portland cement concrete. This runway has been adequately serving tactical B–52 aircraft operations for approximately 2 years.

2. The following is a list of primary use areas at Castle Air Force Base paved with asphaltic concrete:

Facility	Date constructed	Dimensions	Area
			Square yards
Runway	1945–46 and overlay 1954	9,600 x 300 feet	320,000
Main taxiway	1946 and 1952, overlay 1955	7,800 x 100 feet	86,667
Connecting taxiways	Same	4,770 x 100 feet	53,000
ADC area taxiways	1955	1,500 x 75 feet	12,500
Compass rose taxiway	1955	1,850 x 100 feet	20,555
Apron behind main portland cement concrete parking apron.	1953	800 x 300 feet (2 areas)	53,333
Total area			546,055

3. The following is a list of primary use areas at Castle Air Force Base paved with portland cement concrete:

Facility	Date constructed	Dimensions	Area
			Square yards
Parking apron	1955	3,000 by 1,350 feet	450,000
Runway ends	1955	2,200 by 300 feet	73,333
Stub area taxiway	1952	5,600 by 100 feet	62,222
Maintenance stubs	1952	200 by 75 feet by 30 areas	50,000
Connecting taxiways	1956	1,280 by 75 feet	10,667
Do	1952	600 by 100 feet	7,333
South warmup pad	1955	750 by 300 feet	25,000
North warmup pad	1956	1,475 by 400 feet	65,556
Do	1956	915 by 300 feet	30,500
Do	1955	275 by 440 feet	13,444
ADC parking apron	1954 and 1955	730 by 450 feet	36,500
ADC hangar apron	1954	300 by 75 feet	2,500
Do	1954	300 by 150 feet	5,000
Wash rack area	1955	120 by 80 feet by 6 areas	6,400
Do	1955	150 by 30 feet by 5 areas	2,500
Do	1955	160 by 250 feet	4,444
Compass rose	1955	(π) $(150)^2$	7,854
Total area			853,253

(Areas described in items 2 and 3 above pertain to heavy-duty use areas only; shoulders, light-load areas, and surface-treated areas are not included.)

4. The cost figures for the various primary use areas on Castle Air Force Base are very difficult to obtain. This base has been built up in increments over a number of years, with a considerable portion of overlay work. A few areas, consisting of entirely new construction, were taken for cost study. The information on structural section and construction costs was taken from Corps of Engineers' plans and abstracts of bids.

The data for the computations below were extracted from contract documents representing large amounts of work at Castle Air Force Base. The extracted information represents only a small portion of the much larger overall contract. The prices and costs indicated from the extracted data are undoubtedly influenced by the other items of work in the overall contract from which this data was taken. Cost figures are as follows:

(*a*) *Primary runway extension, north end*—Contractor: Peter Kiewit Co. Bids opened October 26, 1954.

Structural section: 4-inch asphaltic concrete on 8-inch stabilized aggregate base course on 24-inch native soil excavated and placed back, compacted to 95 percent density on 6-inch native soil compacted in place to 95 percent density.

Total cost per square yard of structural section: $1.91.

Total area of this work: 26,664 square yards.

(*b*) *Primary taxiway extension, north end.*—Contractor: Peter Kiewit Co. Bids opened October 26, 1954.

Structural section: 4-inch asphaltic concrete on 9-inch stabilized aggegate base course on 23-inch native soil excavated and placed back, compacted to 95 percent density on 6-inch native soil compacted in place to 95-percent density.

Total cost per square yard of structural section: $1.95.

Total area of this work: 25,000 square yards.

(*c*) *Portland cement concrete pavement at north end of runway.*—Contractor: Peter Kiewit Co. Bids opened October 26, 1954.

Structural section: 18-inch portland cement concrete pavement on 6-inch native soil compacted in place to 95 percent density.

Total cost per square yard of structural section: $5.78.

Total area of this work: 33,330 square yards.

(*d*) *Portland-cement concrete pavement at the south end of runway.*—Contractor: Peter Kiewit Co. Bids opened October 26, 1954.

Structural section: 18-inch portland-cement concrete on 6-inch native soil compacted in place to 95-percent density.

Total cost per square yard of structural section: $5.53.

Total area of this work: 26,664 square yards.

A small area at the south end of the runway was overlaid 10-inch portland-cement concrete on the existing pavement. Cost of this overlay was $3.07 per square yard. Total area of this work was 4,444 square yards.

(c) *ADC facilities, access, and operational aprons.*—Contractor: Stolte, Inc. Bids opened March 21, 1955.

Structural section: Both aprons 10-inch portland-cement concrete on 6-inch native soil compacted in place to 95-percent density.

Total cost per square yard of structural section on the access apron: $5.64.

Total area of this work: 2,328 square yards.

Total cost per square yard of structural section for the operational apron: $5.29.

Total area of this work: 7,920 square yards.

5. The only distress observed on the concrete pavements at Castle was in the stub-area taxiway which was constructed in 1952 and consists of 11 inches of portland-cement concrete. The base under this concrete is unknown, but we surmise that it merely consists of native soil compacted in place. The distress in this area consists of broken slabs. The cracks are usually in a straight line and run both longitudinally and transversely in different places. We saw no serious corner breaks nor any great amount of intersecting cracks. Since breaking, the cracks in the slabs have been rooted out and filled with JFR seal. Installations people on the base indicate that they have had difficulty in keeping the tracks filled with the JFR seal and that they have been bothered with considerable spalling at the cracks.

The stub-area taxiways are used to pull the B–52 aircraft into the maintenance docks. When traveling over this taxiway, the aircraft are moving at very slow speeds (towed) and are not excessively loaded.

We examined the southeast end (takeoff and landing end) of the primary runway rather carefully. There is not much change in appearance of the asphaltic concrete in this location from our examination a year ago. One patch has been placed at the junction of the asphaltic concrete and portland-cement concrete and straddling the centerline by about 20 feet on each side. Apparently the asphaltic concrete has been pounded down by the traffic until patching was necessary. There was some evidence of this a year ago and in our inspection report of that time, we indicated that this repair would probably be necessary in the near future.

About 6 months ago 1,500 feet of the runway was worked over with a heater planer and subsequently overlaid with asphaltic concrete. This work was undertaken in order to eliminate surface roughness that existed at that time. The work was extremely successful and both operations people and ground-maintenance people are highly pleased with the results.

They plan to do another 4,000 feet of the same treatment this year. This 4,000 feet will take care of the remainder of the old portion of the asphaltic concrete runway up to the portland-cement concrete at the southeast end.

Travis Air Force Base, Fairfield, Calif.

April 16, 1957—Reported by W. R. Lovering and Vaughn Marker

1. Travis Air Force Base has two parallel runways, both of which are asphaltic concrete with portland-cement concrete ends and are serving current operations satisfactorily. The primary SAC aircraft stationed at this base are B–36's. The field has not been used by either B–47 or B–52 type aircraft except on occasion.

2. The following is a list of primary use areas at Travis Air Force Base paved with asphaltic concrete:

Facility	Date constructed	Area
		Square yards
Runways	Prior to Jan. 1, 1950	226,710
Do	After Jan. 1, 1950	44,872
Taxiways	Prior to Jan. 1, 1950	103,554
Do	After Jan. 1, 1950	37,092
Aprons	do	111,402
Total		523,630

(Some of the very old taxiways in use prior to January 1950 are now available for emergency use only. The structural section is inadequate for anything over approximately 25,000 pounds.)

3. The following is a list of primary use areas at Travis Air Force Base paved with portland-cement concrete:

Facility	Date constructed	Area
		Square yards
Runways	Prior to Jan. 1, 1950	85,683
Do	After Jan. 1, 1950	22,222
Taxiways	Prior to Jan. 1, 1950	184,089
Do	After Jan. 1, 1950	30,042
Aprons	Prior to Jan. 1, 1950	663,847
Do	After Jan. 1, 1950	333,111
Pads	Prior to Jan. 1, 1950	15,555
Total		1,334,549

4. A small area of the ADC apron facilities is paved with tar concrete. The total area of this type is 9,217 square yards.

5. Cost figures for Travis Air Force Base were not readily available; therefore, no comparisons have been made.

6. A visual inspection of the ADC facilities indicated that the aprons, which are part asphaltic concrete and part tar concrete, are both in excellent condition.

The entire apron was constructed of asphaltic concrete several years ago. Approximately 6 months ago work was completed on removing strips of the original asphaltic concrete and replacing them with tar concrete. The tar concrete strips are presently used for parking fighter-type aircraft undergoing maintenance. There seems to be no visible distress in the tar due to fuel spillage, etc.

Both runways appear to be in good condition. There are no visible evidences of distress on either the asphaltic concrete or the portland cement concrete portions due to the loads that have been imposed to date. Except for intermittent touch-and-go landing, no use has been made of these runways by B–52 or B–47 type aircraft. One of the runways has a very extensive subdrain system underneath it and it is the opinion of the base maintenance personnel that the excellent performance of this runway, in part, can be attributed to this fact. They also believe that, due to this construction, the runway will probably be capable of withstanding B–52 aircraft, if and when they are assigned to the base. There are no problems or complaints concerning the runways by either air installations personnel or the base operations personnel.

Virtually all of the parking and maintenance areas on the base, with the exception of the ADC facilities, are portland cement concrete. Some of these areas apparently are approximately 15 years old and built to the standards of their time. All of the portland cement concrete aprons, regardless of their age, are in very good condition. There is little, if any, distress apparent due to the loads (B–36) that have been imposed to date. Again, there are no problems or complaints by either the air installations personnel or base operations personnel on these concrete areas.

Fairchild Air Force Base, Spokane, Wash.

April 10, 1957—Reported by Rodney P. Ryker

1. Fairchild Air Force Base has an asphaltic concrete runway with a portland cement concrete runway extension at the northeast end. To date, neither B–47 nor B–52 type aircraft have been used at this station, but there has been extensive use of the B–36 aircraft ever since completion of the new runway in 1952–53. It is anticipated that B–52 type aircraft will be phased into the station as they become available.

2. The following is a list of primary use areas at Fairchild Air Force Base paved with asphaltic concrete:

Facility	Date	Total pavement and base	Pavement thickness (asphaltic concrete)	Area
		Inches	*Inches*	*Square yards*
Northeast-southwest runway	1951, 1952 and 1953	24	4	233,333
Taxiway No. 1	do	24	4	122,122
Taxiway No. 2	do	24	4	44,111
Taxiway No. 3	do	24	4	24,444
Taxiway No. 4	do	24	4	20,544
Taxiway No. 5	do	24	4	7,222
Taxiway No. 6	do	18	4	17,100
Taxiway No. 7	do	24	4	8,888
Ladder taxiway No. 1	do	24	4	99,222
Ladder taxiway No. 2	do	24	4	10,033
Transient apron	do	24	4	85,650
Northeast warmup apron	do	24	4	42,770
Southwest warmup apron	do	24	4	22,041
Subtotal				707,480
Hardstand service area	1951, 1952 and 1953	24	3	31,500
Subtotal				738,980
Northeast-southwest runway widening and extensions	1956	24	4	157,011
Total area of asphaltic concrete				895,991

3. The following is a list of primary use areas at Fairchild Air Force Base paved with portland-cement concrete:

Facility	Date	Total pavement and base	Pavement thickness	Area
		Inches	*Inches*	*Square yards*
Warmup pad	1956	24	PCC–16	27,777
Do	1956	24	PCC–16	35,000
Access apron	1956	24	PCC–16	284,444
Total area of portland cement concrete				347,221

4. Cost figures shown below are based on the 1956 contract. Figures on earlier contracts were not readily available.

(*a*) *Northeast-southeast runway widening and extensions.*—

Structural section: 4-inch asphaltic concrete on 6-inch crushed rock base course on 14-inch crushed rock subbase course on compacted subgrade.

Total cost per square yard of structural section: $2.515.

Total area of this work: 157,011 square yards.

(*b*) *Northeast-southwest runway extension (NE).*—

Structural section: 16-inch portland cement concrete pavement on 4-inch crushed rock base course on 4-inch crushed rock subbase course on compacted subgrade.

Total cost per square yard of structural section: $4.99.

5. The pavement evaluation report by the Corps of Engineers, dated July 1955, had the following statement concerning the pavement condition:

"Pavement failure occurred on taxiway No. 6. Pavement was patched at least twice. Ladder taxiway No. 1 shows indications of rutting and contains longitudinal cracking. One electrical duct bank crossing runway settled after first winter. The pavement was patched with hot asphaltic concrete mix and no further settlement occurred. A hot-mix overlay on primary runway between station 81+50 and station 86+50 to level a rough area caused by consolidation of compressible foundation materials."

Interview with Harry P. Stokes, installation engineers office, April 8, 1957. Mr. Stokes is the civilian engineer in charge of maintenance of the base for the AIO.

We were shown photographs dated March 1957, taken by the Air Force, of base consolidation caused by channelized traffic. There were numerous photographs

taken in different locations on taxiways and hangar access stubs, showing rutting up to 2 inches deep. Parallel longitudinal cracking was evident in the photographs with cross ladder cracks beginning to appear. There also was some complaint about asphaltic concrete softening when exposed to oil and fuel dripping, and the statement was made that they did not have the manpower to do a good housekeeping job.

The primary runway is in excellent condition according to Stokes, with no distress except that which occurred shortly after construction and mentioned in the Corps of Engineers evaluation report. This particular individual feels that runways can be built of asphaltic concrete to handle B–52's.

THE ASPHALT INSTITUTE,
SOUTHWEST DIVISION,
Dallas, Tex., April 10, 1957.

Subject: Dyess Air Force Base construction costs.

Mr. A. S. WELLBORN,
Chief Engineer, the Asphalt Institute,
College Park, Md.

Attached are two copies of paving costs on Dyess (Abilene) Air Force Base which includes the new construction completed on December 22, 1954. This information was obtained from the contractor's final estimate; therefore, the quantities are somewhat different from the original plan quantities. I want to call your attention to the fact that the square-yard cost of the four different sections of flexible pavement includes the extra width base course and subbase materials for shoulders.

This airfield has been carrying a medium volume of B–47 traffic for over 2 years with no real signs of distress. Condition of pavement of this air base was reported to you March 26.

HUGH A. WALLACE,
Managing Engineer, Southwest Division.

Dyess (Abilene) Air Force Base, Abilene, Tex., (formerly known as Tye AFB), cost data from contractors final estimate construction completed Dec. 22, 1954

FLEXIBLE PAVEMENT COST

North-south runway, station 200+00 to 260+00; 133,333 square yards:	
Crushed stone base course, 6 inches, 22,222 cubic yards, at $3.21	$71,332.62
Subbase No. 1, 10 inches, 41,736 cubic yards, at $2.70	112,687.20
Subbase No. 2, 25 inches, 98,464 cubic yards, at $2.60	256,006.40
Prime coat, 39,200 gallons, at 14 cents	5,488.00
Tack coat, 4,150 gallons, at 16 cents	664.00
Hot mix surface course, 1½ inches, 10,987 tons, at $4.79	52,627.73
Hot mix binder course, 2½ inches, 18,340 tons, at $4.88	89,499.20
Asphalt for hot mix, 327,172 gallons, at 10 cents	32,717.20
Total	621,022.35
Cost per square yard	4.657
North-south runway station 260+00 to 292+00; 71,111 square yards:	
Crushed stone base course, 6 inches, 11,852 cubic yards, at $3.21	38,044.92
Subbase No. 1, 10 inches, 22,350 cubic yards, at $2.70	60,345.00
Subbase No. 2, 16 inches, 33,101 cubic yards, at $2.60	86,062.60
Prime coat, 20,906 gallons, at 14 cents	2,926.84
Tack coat, 2,150 gallons, at 16 cents	344.00
Hot mix surface course, 1½ inches, 5,925 tons at $4.79	28,380.75
Hot mix binder course, 2½ inches, 9,890 tons at $4.88	48,263.20
Asphalt for hot mix, 176,432 gallons, at 10 cents	17,643.20
Total	282,010.51
Cost per square yard	3.965

Dyess (Abilene) Air Force Base, Abilene, Tex., (formerly known as Tye ANB), cost data from contractors final estimate construction completed Dec. 22, 1954—Con.

FLEXIBLE PAVEMENT COST—continued

North-connecting taxiway and taxiway Y; 18,638 square yards:	
Crushed stone base course, 6 inches, 3,106 cubic yards, at $3.21	$9,970.26
Subbase No. 1, 10 inches, 5,905 cubic yards, at $2.70	15,943.50
Subbase No. 2, 30 inches, 16,331 cubic yards, at $2.60	42,460.60
Prime coat, 5,490 gallons, at 14 cents	768.60
Tack coat, 560 gallons at 16 cents	89.60
Hot mix surface course, 1½ inches, 1,534 tons at $4.79	7,347.60
Hot mix binder course, 2½ inches, 2,609 tons, at $4.88	12,731.92
Asphalt for hot mix, 46,219 gallons, at 10 cents	4,621.90
Total	93,933.98
Cost per square yard	5.039
South-connecting taxiway and taxiway Z; 19,002 square yards:	
Crushed stone base course, 6 inch, 3,167 cubic yards, at $3.21	10,166.07
Subbase No. 1, 10 inch, 6,005 cubic yards at $2.70	16,231.50
Subbase No. 2, 20 inch, 11,060 cubic yards, at $2.60	28,756.00
Prime coat, 5,587 gallons, at 14 cents	782.18
Tack coat, 596 gallons, at 16 cents	95.36
Hot mix surface course, 1½ inches, 1,564 tons, at $4.79	7,491.56
Hot mix binder course, 2½ inches, 2,661 tons, at $4.88	12,985.68
Asphalt for hot mix, 47,141 gallons, at 10 cents	4,714.10
Total	81,222.45
Cost per square yard	4.274

RIGID PAVEMENT COST

Apron, 1 taxiway and 1 runway end; 448,265 square yards:	
Portland cement concrete pavement, 16 inch, 448,265 square yards, at $3.30	1,479,274.50
Select material subbase, 6 inch, 75,159 cubic yards, at $2.25	169,107.75
Cement, 252,064 barrels, at $3.25	819,208.00
Total	2,467,590.25
Cost per square yard	5.505
One taxiway and 1 runway end; 55,555 square yards:	
Portland cement concrete pavement, 16 inch, 55,555 square yards, at $3.30	183,331.50
Cement, 31,154 barrels, at $3.25	101,250.50
Total	284,582.00
Cost per square yard	5.126

THE ASPHALT INSTITUTE, SOUTHWEST DIVISION,
Dallas 6, Tex., April 10, 1957.

Subject: Altus Air Force Base construction costs.

Mr. A. S. WELLBORN,
Chief Engineer, The Asphalt Institute,
University of Maryland, College Park, Md.:

Attached is construction cost data just received from Mr. H. S. Hudson.

You will note that the first sheet is cost data on the flexible pavement constructed by Metropolitan Paving Co. and is the pavement (apron, taxiways, and runway) that we inspected about 1 year ago. Pavement remaining in place since our inspection has not changed very much; however, some areas have required considerable maintenance.

The second sheet is cost data on the Peter Kiewit Sons & Co. contract that is still in progress. It covers the replacement of flexible-type apron with port-

land cement concrete only. The Kiewit contract also included runway widening and lengthening, but cost data on this portion is not stated.

HUGH A. WALLACE,
Managing Engineer, Southwest Division.

Altus Air Force Base—Runways, apron, taxiways

Contractor: Metropolitan Paving Co.
Bid: (all items) $3,058,205.
Final: (all items) $2,988,613.78—February 18, 1954.

RUNWAYS

4-inch asphaltic concrete: 1½-inch surface; 2½-inch binder.

CBR values
80. 6-inch crushed stone—100-percent Proctor.
58. 6-inch salvaged existing material+20 percent sand—100 percent Proctor.
37. 5-inch dune sand—100 percent Proctor.
15–20. 7-inch select soil—95 percent Proctor.

Basis:

Prime, 0.30 square yard, at $0.14	$0.042
Tack, 0.15 square yard, at $0.14	.021
Asphaltic concrete, 6 percent at $0.0132 per pound	.399
158 pounds/square yard at $4.79	.378
295 pounds/square yard at $5.04 ton	.750
0.166 cubic yard at $5.49 cubic yard	.911
0.166 cubic yard at $0.89 cubic yard	.148
0.139 cubic yard at $1.17 cubic yard	.162
0.194 cubic yard at $0.19 cubic yard	.038
1 square yard at $1.14 per square	.103
Cost per square yard	2.952

200 feet wide by 10,800 feet long. Design—100,000 pound wheel load.

APRON

4-inch asphaltic concrete: 1½-inch surface; 2½-inch binder.
6-inch crushed stone.
5-inch salvaged existing base+20 percent sand.
6-inch dune sand.
6-inch old portland cement concrete.

Basis:

Prime, 0.30 square yard at $0.14	$0.042
Tack, 0.15 square yard at $0.14	.021
Asphaltic concrete, 6-percent square yard at $0.0132 per pound	.399
158 pounds per square yard at $4.79 per ton	.378
295 pounds per square yard at $5.04 per ton	.750
0.166 cubic yard at $5.49 cubic yard	.911
0.139 cubic yard at $0.89 cubic yard	.124
0.166 cubic yard at $1.17 cubic yard	.194
Cost per square yard	2.819

Additional apron widened 150 feet consisted of additional material to total thickness of 32 inches. Cost not figured.

Maintenance by contract to Steelman Construction Co. for sealing runways and taxiways for $33,278.50, August 1956.

Altus Air Force Base

Contractor: Peter Kiewit Sons & Co.
Bid (all items): $3,016,161.
Contract let: August 15, 1956; still in progress.

Bid items	Design criteria	240,000 pounds	Gear load
1. Grading	$308,531	Sum	Job.
1A. Removal and replacement of unsuitable subgrade material.	3,500	5,000	Cubic yard.
2. Removal of KC-97 nose dock from south end of apron.	5,000	Sum	Job.
3. Replacement of KC-97 nose dock on south end of apron.	6,000	Sum	Do.
4. Portland cement concrete pavement	1,440,000	180,000	Cubic yard.
5. Cement for concrete pavement	1,042,200	270,000	Barrel.
6. Replacement of concrete pavement in test holes	1,000	10	Each.
7. Asphaltic-concrete pavement	52,000	Sum	Job.
8. Filter course	148,500	330,000	Square yard.
9. Blast area markings	150	Sum	Job.
10. Tie-down anchors	9,280	3,200	Each.

Based on total cost of bid items 4, 5, and 8 for 330,000 square yards, the cost per square yard is $7.984.

By telephone to engineering section, Altus Air Force Base, the total square yards of asphaltic concrete on runway and taxiways will be 561,253, and of portland cement concrete will be 758,281 when Kiewit job is finished.

THE ASPHALT INSTITUTE,
MIDWEST DIVISION,
St. Paul, Minn., April 22, 1957.

Re Air Force base information.
Mr. A. S. WELLBORN,
Chief Engineer, The Asphalt Institute,
College Park, Md.

DEAR MR. WELLBORN: Herewith is information on the following Air Force bases: Smoky Hill Air Force Base, Kans., and Forbes Air Force Base, Kans.

We are led to believe that both of the above two fields are performing satisfactorily.

Ellsworth Air Force Base, Rapid City, S. Dak.:

As you will note, this latter airbase has been under almost constant construction since 1942. We were unable to get the cost records for this work. We were informed by the Corps of Engineers at Omaha that a performance survey has been made and that it was in the Office of the Chief Engineer in Washington, D. C. I believe it was also understood that they had a complete cost record on file there. It is our general impression that this field is giving good performance for B–36, B–47, and B–52 operation.

Little Rock Air Force Base, Ark.
Air Force Base, Minot, N. Dak.
Lincoln Air Force Base, Lincoln, Nebr.
Air Force Base, Grand Forks, N. Dak.

Very truly yours,

W. L. HINDERMANN, PE.,
Managing Engineer, Midwest Division.

Smoky Hill Air Force Base, Kans.

Feature	Area	Thickness
	Square yards	
Runway 17-35	296,000	Interior, 12-14-inch overlay on 8 inches. Interior, 16-17 inches. North end, 19 inches. South end, 17 inches.
Parking apron	185,900	18 inches.
Do	301,200	17 inches.
Do	355,300	13-15-inch overlay on 8 inches.
Access taxiway		17 inches.
South taxiway	9,200	Do.
North taxiway	23,021	Taxiway, 19 inches.'
North warmup pad		Warmup pad, 17 inches.
Apron-access taxiway	62,930	17 inches.
Hangar apron	73,270	Do.
Calibration hardstand	12,000	Do.

COST DATA

Cost on portland-cement concrete construction 1952–56:

16 inches at $6.32, $6.43 square yard.
17 inches at $6.67, $7.55, $6.72, $6.90 square yard.
17 to 19 inches at $8.01 square yard.
19 inches at $8.66 square yard.
Overlay, $13.75 cubic yard; $14.19 cubic yard.

Asphalt construction on these bases is limited to pavement shoulders that are 25 feet in width with 13 inches of base and 2 inches asphaltic concrete.

These runways were initially built in 1942 and 1943 with overlay construction indicated being built in the years between 1952 and 1956. Runways are 200-feet-wide portland-cement concrete construction placed on subgrade.

Forbes Air Force Base, Kans.

Feature	Area	Thickness
	Square yards	
Runway 13-31	284,000	Ends, 17 inches; interior, 16 inches.
Runway 3-21	178,000	Ends, 18 and 15 inches; overlay, 10-8-10 inches; interior, 14 inches; overlay, 10-8-10 inches.
Parking apron	250,000	14 and 15 inches; overlay, 9-7-9 inches.
Do	59,000	13 and 14 inches; overlay, 10-8-10 inches.
Do	138,000	17-inch portland-cement concrete.
Parking apron, warmup pad, taxiway	593,000	Do.
Hangar apron	34,000	16 and 17 inches.
Do	42,000	16 inches.
Taxiway and warmup pad	54,000	18 inches.
Do	124,000	17 inches.
Taxiway and calibration hardstand	16,000	Do.
Hangar-access taxiway	22,000	Do.

COST DATA

Cost of portlant-cement concrete construction from 1952–1956:

16 inches at $6, $5.86 square yard.
17 inches at $6.37, $6.70, $7.54, $6.20, $6.81 square yard.
Overlay, $14 cubic yard.

Asphalt construction on these bases is limited to pavement shoulders that are 25 feet in width with 13 inches of base and 2 inches asphaltic concrete.

These runways were initially built in 1942 and 1943 with the overlay construction indicated being built in the years between 1952 and 1956. Runways are 200-feet-wide portlant-cement concrete construction placed on subgrade.

Ellsworth Air Force Base, Rapid City, S. Dak.—History of construction

Part of field	Approximate square yards	Date	Construction
Northwest-southeast runway	284,000	1951	5-inch asphaltic concrete overlay.
		1943	7-inch portland cement.
		1942	3-inch asphaltic concrete.
		1942	8-inch gravel base.
Northwest-southeast runway end (southerly extension).	57,200	1950	3-inch asphaltic concrete.
		1950	12-inch base.
		1950	15-inch subbase.
Northwest-southeast runway extension (northerly extension).	100,000	1956	19-inch portland cement (end 1,000 feet).
			17-inch portland cement (center 2,000 feet).
			4-inch portland cement base.
Taxiway No. 1 from northwest-southeast runway end.	20,200	1950	3-inch asphaltic concrete.
			12-inch base.
			15-inch subbase.
Taxiway from rigid runway extension	40,700	1956	19-inch portland cement (outside).
			22-inch portland cement (center).
			4-inch base.
Taxiways 1, 2, and 3	73,400	1953	21-inch portland cement.
			4-inch base.
Taxiway to loading docks	42,000	1953	4-inch asphaltic concrete.
			12-inch base.
			29-inch subbase.
Taxiway in front of parking apron J2	33,700	1950	4-inch asphaltic concrete.
			12-inch base.
			28-inch subbase.
Parking apron	198,500	1950	1½-inch tar.
(NOTE: A small part of this is 4-inch asphaltic concrete over 7-inch portland cement and 11½-inch flexible (asphaltic concrete overlay in 1956.)			2½-inch asphaltic concrete.
			12-inch base.
			27-inch subbase.
Apron	100,000	1953	2½-inch asphaltic concrete overlay.
		1942	7-inch portland cement, no base.
Maintenance aprons M2 and M3 (built around taxiways 1, 2, and 3).	42,300	1953	13-inch portland cement
			4-inch base.
Maintenance aprons M4 and M5	81,400	1954–55	17-inch portland cement.
			4-inch base.
Taxiways along aprons and connecting taxiway No. 2.	71,400	1955	4-inch asphaltic concrete.
			6-inch base.
			33-inch to 42-inch subbase.
Heavy maintenance apron and taxiway G	103,000	1950	4-inch asphaltic cement.
			12-inch base.
			28-inch subbase.
Center connecting taxiway	17,100	1950	4-inch asphaltic cement.
			12-inch base.
			28-inch subbase.
2 warmup pads	25,300	1956	19-inch portland cement.
			4-inch base.
Wash rack	5,300	1954	17-inch portland cement (wings 12-inch).
			4-inch base.
Air Defense Command alert	8,340	1951–52	2-inch asphaltic cement.
			6-inch base.
			15-inch subbase.
M6, extension to M5, extension to L1, 2, and 3, taxiways and extension to south apron.	81,000	[1]	19-inch portland cement.
			4-inch base.

[1] Under construction.

There is a total of approximately 935,000 square yards of flexible and 449,000 square yards of rigid pavement on this airbase.

LITTLE ROCK AIR FORCE BASE

Asphalt

Date completed	Components of pavement			Designation area	Length	Width	Area square yards	Cost per square yard
	Subbase	Base	Asphaltic concrete					
	Inches	*Inches*	*Inches*		*Feet*	*Feet*		
August 1955	[1] 14	[1] 6	4	Primary runway	8,100	200	180,090	$3.14
Do	[1] 17	[1] 6	4	East taxiway	[2] 1,000	75	8,350	3.37
Do	[1] 17	[1] 6	4	Taxiway	720	75	6,750	3.37
Do	[1] 17	[1] 6	4	do	720	75	6,750	3.37
Do	[1] 17	[1] 6	4	do	627	75	5,225	3.37
October 1955	[1] 17	[1] 6	4	Access taxiway	112.5	75	937.5	3.37

[1] Crushed rock.
[2] Curve approximately.

PRESENT CONDITION AND PERFORMANCE RECORD

Asphalt-paved areas.—The Corps of Engineers' office in Little Rock has indicated that the general performance of the runway has been good. However, the transition area from the rigid portland cement to asphaltic concrete on either end of the runway has shown distress and at the present time the asphaltic concrete is somewhat lower than the rigid material. It has been necessary to do some maintenance work in order to minimize this drop in elevation from rigid to flexible. Also, in similar transition points on the taxiways, there has been an even greater degree of maintenance necessary, which is believed due in part to channelized loading on these sections, but even on the taxiways no apparent distress has developed outside the transition area.

Portland cement

Date completed	Components of pavement		Designation area	Length	Width	Area square yards	Cost per square yard
	Base	Portland cement concrete					
		Inches		*Feet*	*Feet*		
August 1955	None	15	West end of primary runway.	1,000	200	22,222.22	$5.06
Do	None	15	East end of primary runway.	1,000	200	22,222.22	5.06
Do	None	15	Operation area and taxiway.	8,460 3,925	75 1,150	572,027.7	5.06

Portland cement paved areas.—There has been no apparent distress developed on the portland cement areas to date. However, considerable work has been done to develop a method for better sealing of joints between the slabs since it is apparent that the water is moving down through the joints on to the subgrade, and without question in all future designs of this type a granular subbase will be specified, which will in part provide a satisfactory foundation for rigid pavement even though the joints are not properly sealed.

LINCOLN AIR FORCE BASE, LINCOLN, NEBR.

Type traffic: B–47, commercial and jet fighter.
Volume traffic: Approximately 2,800 to 3,000 B–47 landings per month.

NORTH-SOUTH RUNWAY

Physical layout:
Runway width: 200 feet.
Going from south to north:
Section A: 1,000 feet portland cement concrete—Completed January 1955
Section B: 8,600 feet asphaltic concrete—Completed January 1955
Section C: 1,000 feet portland cement concrete—Completed January 1955
Section D: 2,300 feet portland cement concrete—Completed September 1956

Pavement design:
Section A: 19 inches portland cement concrete on 4 inches granular filter course
Section B:
1½ inches surface course
2½ inches binder course
6 inches—80 CBR base material
7 inches—35 CBR base material
16 inches and 30 inches—20 CBR base material

Going from south to north the following thickness changes are made in flexible pavement:

Distance (feet)	Total thickness (inches)	Thickness 20 CBR material
1,700	33	16
1,900	47	30
1,100	33	16
800	47	30
3,100	33	16

Section C: 19 inches portland cement concrete plus 4 inches granular filter course.

Section D: Going from south to north the following thickness changes were made in rigid pavement:

Distance (feet)	Total thickness (inches)	Thickness portland cement concrete (inches)	Thickness granular filter course (inches)
1,300	21	17	4
800	23	19	4
800	25	21	4

The 21-inch portland cement concrete is considered blast area. Warmup pads are of 19-inch portland cement concrete plus 4-inch granular filter course.

Total area represented in square yards

	Flexible	Rigid
(a) Runways	191,092	95,550
(b) Taxiways	31,842	90,565
(c) Parking and operational apron		1,161,274
(d) Paved shoulders	49,983	
(e) Warmup pads		38,914
Total	272,917	

Cost per square yard, each pavement design

Pavement section	Total thickness	Cost per square yard
Flexible runway	33	$4.69
Do	47	6.28
Flexible taxiway	52	6.82
Rigid runway	21 (17 portland cement plus 4)	7.00
Do	23 (19 plus 4)	7.87
Rigid taxiway and blast	25 (21 plus 4)	8.56

All rigid pavement sections have 4 inches of granular filter course.

The following typical densities obtained from construction records were used to calculate cost per square yard:

	Pounds per cubic foot
80 CBR base materials	137.0
35 CBR base materials	136.4
20 CBR base materials	136.4
Binder course, 4 percent asphaltic concrete	147.0
Surface course, 5.4 percent asphaltic concrete	147.0
Granular filter course	122.0

Unit price and final quantities

	Unit	Unit price	Final quantities
North-south runway:			
Granular filter course	Ton	$2.00	9,021.87
Concrete pavement	Cubic yard	7.50	23,542.54
Cement	Barrel	4.00	33,842.40
35 CBR subbase	Ton	2.20	80,129.16
20 CBR subbase	do	2.20	213,560.66
80 CBR base	do	2.85	70,353.26
Prime coat	Gallon	.12	73,780.30
Tack coat	do	.12	8,149.30
Surface course	Ton	4.70	16,648.60
Binder course	do	4.70	27,183.40
Bituminous material for binder and surface course	Gallon	.08	487,318.50
Taxiway:			
Granular filter course	Ton	2.00	6,503.60
Concrete paving	Cubic yard	7.50	19,585.34
Cement for paving	Barrel	4.00	16,098.71
35 CBR subbase	Ton	2.20	12,462.30
20 CBR subbase	do	2.20	35,777.99
80 CBR base	do	2.85	12,020.05
Prime coat	Gallon	.12	17,904.00
Tack coat	do	.12	699.00
Surface course	Ton	4.70	7,780.00
Binder course	do	4.70	4,123.25
Bituminous material for binder and surface course	Gallon	.08	144,323.00

The runway is in excellent condition except for ends of flexible section where they join rigid sections. Mr. W. H. Osterberg, chief for installations office, Lincoln Air Force Base, indicates that flexible pavement has settled 1½ inches at points where it joins rigid sections. There was little, if any, maintenance on these joints. He indicated plan of repair will include heater planing at point 60 feet from joint and replacing with hot-mix patch 1 to 1½ inches thick.

MINOT (N. DAK.) AIRBASE

Average section flexible pavement (runway):
- 4-inch filter course
- 38-inch subbase course
- 20-inch subbase course
- 6-inch base course
- 2½-inch asphaltic concrete binder course
- 1½-inch asphaltic concrete surface course

Average section rigid pavement (runway):
- 4-inch filter course
- 52.05-inch subbase course (50 to 56 inches)
- 15.94-inch portland cement concrete (12 to 18 inches)

Item	Unit price bid	Unit	Portland cement, rigid	Asphaltic cement, flexible
4-inch filter	$0.36	Square yard	$0.36	$0.36
38-inch subbase	2.50	do		2.50
52.05-inch average subbase	3.40	do	3.40	
20-inch subbase	2.00	do		2.00
6-inch base	2.40	do		2.40
Bituminous prime	.15	Gallon		.04
Bituminous tack	.15	do		.02
15.94-inch average concrete	12.60	Cubic yard	5.58	
Portland cement	6.50	Barrel	4.14	
2½-inch binder	10.00	Ton [1]		1.68
1½-inch surface	10.00	do [1]		1.03
Bid price per square yard			13.48	10.05

[1] Plus asphaltic cement at 20 cents per gallon.

NOTE.—The above prices per square yard are based on the low bid in the letting of March 1957. There were approximately 406,580 square yards of rigid pavement and 160,500 square yards of flexible pavement in this letting. The basic design is 100 feet of rigid pavement with 100 feet of flexible pavement on each side of the runway.

GRAND FORKS, N. DAK., AIRBASE

The typical section in this airbase, which is all rigid pavement, except for the roads and streets, for the building area is 16- to 24-inch portland cement concrete on a 12- to 23-inch base course and 4-inch filter course placed on select material in the subgrade. These bids were taken March 13, 1957.

Item	Unit	Unit price	Portland cement concrete cost per square yard
4-inch filter	Square yard	$0.30	$0.30
16.13-inch average base	do	[1]	1.29
19.52-inch average concrete pavement	Cubic yard	10.30	5.58
Cement	Barrel	5.20	4.23
Bid price per square yard			11.40

[1] Various.

Sample calculations:

19.52″÷36″=0.5422×$10.30=$5.58

Cement 1.50 barrel×0.5422×$5.20=$4.23

THE ASPHALT INSTITUTE,
MIDWEST DIVISION,
St. Paul, Minn., April 24, 1957.

Re Air Force base information.

Mr. A. S. WELLBORN,
Chief Engineer, the Asphalt Institute, College Park, Md.

DEAR MR. WELLBORN: Transmitted herewith is additional information on Air Force bases in this division.

On April 17 Jack Pearring made an inspection of the Hill Air Force Base at Ogden, Utah. This runway was completed last year. On May 22, 1956, I gave to you a brief report on some of the difficulties which were encountered in respect to the construction of the asphalt portion of the runway.

Very truly yours,

W. L. HINDERMANN, PE,
Managing Engineer, Midwest Division.

HILL AIR FORCE BASE, OGDEN, UTAH

(From John F. Pearring, district engineer, the Asphalt Institute, Denver, Colo., April 23, 1957)

Pursuant to our discussion, a visit was made to the Hill Air Force Base at Ogden, Utah, for the purpose of performing a close inspection of the condition of the 13,438-linear-foot runway, which was completed in October 1956 under contract with Peter Kiewit Sons Co. The inspection was made in the company of Mr. Larry Fine, resident engineer, United States Corps of Engineers, contracting agency on the project, on Wednesday, April 17, 1957.

The inspection revealed the pavement surface to be in excellent condition. Not one distressed area has been noticed to date. During the construction you may recall that the southern half, comprising a total of approximately 10,000 linear feet was constructed first so that traffic was uninterrupted. At the completion of the first section traffic was then placed on this section with construction continuing on the northern portion, comprising approximately 3,500 linear feet. As was reported earlier, some portions of the surface were exposed to jet blast due to the inconvenience caused by construction. These areas were not effectively damaged by the jet blast, with only the thin surface film being removed. Additional areas since the opening of the entire runway show "scorched" surfaces due to jet blast, but these also contain no effective damage. Some of the scorched surfaces have been treated with the use of "jennite" by maintenance personnel located on the base. We might add that the results seem to be very satisfactory inasmuch as the treatment has replaced a thin mortar film.

The riding qualities of the asphalt pavement continue to remain in the excellent category. There have been no indications of apparent settlement or subsidence to date. Many of the pilots of the various craft that have used the runway have remarked about the smooth riding condition. On the other hand, the 1,000-linear-foot runway ends, consisting of portland cement concrete, do not contain even a reasonable comparison with regard to smoothness. You may recall that we reported earlier that the criteria tolerances from true grade had to be relaxed on the portland cement concrete sections due to uncontrolled shrinkage and the like. Many of the slabs contain transverse cracks, which were reported due to low humidity conditions during placement and curing. The following is a tabulation of costs of the two pavement types used on the runway. This information was obtained from the United States Corps of Engineers regional office in San Francisco, Calif., by Mr. Vaughn Marker, district engineer, the Asphalt Institute.

Asphalt concrete

Material (typical section)	Thickness (inches)	Cost per squar yard
Bituminous surface course	1½	$0.50
Tack coat		.01
Bituminous binder course	2½	.79
Prime coat		.04
Stabilized aggregate base course at 100 percent compaction	6	.45
Select material base course type A at 100 percent compaction	12	1.20
Compacted subgrade at 95 percent compaction		.18
Total thickness	22	
Total cost of structural section		3.17

Portland cement concrete

Material (typical section)	Thickness	Cost per square yard
Portland cement concrete	19, 15, 19 inches, outer 12½ feet both edges of runway go from 15 to 19 inches in thickness.	$6.12
Total thickness	19, 15, 19 feet.	
Total cost of structural section		6.12

THE ASPHALT INSTITUTE,
OHIO VALLEY-GREAT LAKES DIVISION,
Columbus, Ohio, April 25, 1957.

Mr. ARVIN S. WELLBORN,
Chief Engineer, The Asphalt Institute,
University of Maryland, College Park, Md.

DEAR MR. WELLBORN: This is in reply to your recent request for as much information as we could collect about the concrete paving and asphalt surfacing done at Lockbourne Air Base in 1951.

The cost records have been pretty badly scattered. Some of them are in Huntington and some in the St. Louis office at present. I have been able to secure a few, which may or may not be of value to you.

The asphalt concrete resurfacing on the runway consisted of approximately 101,000 square yards, 6 inches thick. This was placed on the badly disintegrated 8 inches of plain portland cement concrete. Our feeling is that this 8 inches of old concrete could not be considered for design purposes, other than a high grade flexible pavement base.

The cost of this 6 inches of asphalt resurfacing including sweeping, tack coat, mix, asphalt cement, and seal coat was approximately $3.55 square yard. The cost of the new 11-inch concrete portion of the runway was approximately $6.65 square yard, and the 12-inch portion of the new concrete runway was $7.08 square yard. The old 8-inch concrete apron was resurfaced with 7 inches of asphaltic concrete overlay at a cost of approximately $3.65 square yard, including all items listed above. Square yardage of apron resurfacing is indeterminate because of extra work areas and other adjustments. However, it is approximately 420,000 square yards.

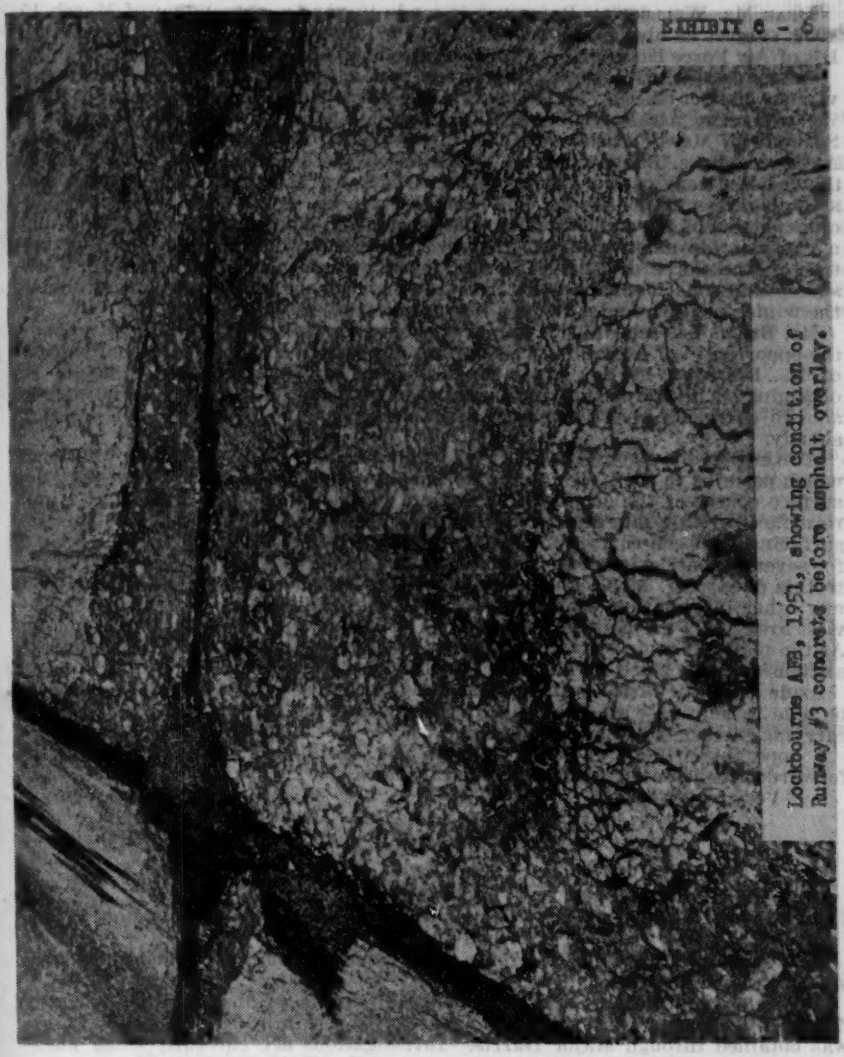
Maintenance costs on the asphaltic concrete overlay since placing have been negligible. Extensive maintenance will be required this year on the concrete sections constructed in 1951 and considerable joint and corner maintenance has been required heretofore. All of the 1957 maintenance program will be devoted to removing and replacing defective portland cement concrete slab, none being anticipated on the overlay sections.

Lockbourne Air Base engineers inform us that this base has the highest concentration of B–47 traffic of any base in the United States, with occasional handling of B–52 and other heavy aircraft. As you know, this overlay work on the runway is subject to channelized traffic and there is absolutely no sign of rutting or displacement.

We hope that this information will be of some value to you.

Very truly yours,

J. H. GOSHORN,
Managing Engineer, Ohio Valley-Great Lakes Division.



Lockbourne AFB, 1951, showing condition of Runway #3 concrete before asphalt overlay.

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THE ASPHALT INSTITUTE,
ATLANTIC-GULF DIVISION,
New York, N. Y., April 16, 1957.

Subject: Airfield pavements.

Mr. A. S. WELLBORN,
Chief Engineer, The Asphalt Institute,
Asphalt Institute Building,
University of Maryland, College Park, Md.

DEAR MR. WELLBORN: Reference is made to your memorandum of March 15, 1957, subject as above, and to your letter of March 28, 1957, which attached a list of Air Force bases utilized for heavy bomber operations.

In connection with these letters, we have requested information from our various district offices. Mr. Robert C. Briggs has furnished information pertaining to Loring Air Force Base, Limestone, Maine; Westover Air Force Base, Springfield, Mass.; Portsmouth Air Force Base, Portsmouth, N. H.; and Dow Air Force Base, Bangor, Maine. In addition to the information contained on the enclosed copy of Mr. Briggs' report, I have learned by telephone that a considerable amount of difficulty has been experienced on the portland cement concrete portion of the airfield which was constructed last year. I understand that a considerable amount of controversy is presently ensuing between the contractor, the Corps of Engineers, and the Air Force. Apparently use of frost susceptible soils has caused deformation and some pavement breakage during the winter months, and a remedy has not as yet been determined.

Mr. Briggs has scheduled a trip to this base on Wednesday and hopes to have the opportunity of examining this portion of the field and to obtain photographs of it. However, he has experienced a considerable amount of difficulty in obtaining such information and he is not sure of the extent to which he will be able to carry his investigation. A further report of this will be forthcoming shortly.

Also enclosed is a copy of a short report obtained from Mr. Charles A. McKeogh which pertains to the Kelly Air Force Base test section. You will note that the surface course of the original test section was removed by a blade grader and resurfaced with a mix similar to that used elsewhere on the airfield. This resurfacing has been carrying B–52's and B–47's, as well as other heavy aircraft, for several months since conclusion of the tests and has shown no sign of failure to this date. Mr. McKeogh has promised to furnish us with his thoughts and any other information which he is able to obtain on other fields in the Southwest area and I am hopeful that other information will be forthcoming shortly. As the material arrives I will forward it along to you since I know that you are anxious to get as much of this assimilated as possible.

Aside from the airbases in New England and those which Mr. McKeogh may be able to help us with, the bases in Florida are the only ones in this division carrying extremely heavy plane loads.

I hope this will be of some value to you. Additional information will be forwarded immediately upon receipt in this office.

Very truly yours,

ROBERT B. MCKEAGNEY,
Division Managing Engineer, Atlantic-Gulf Division.

AIRFIELD INFORMATION

(From Robert C. Briggs, District Engineer, the Asphalt Institute, Boston, Mass., April 12, 1957)

This memorandum is in reference to a memorandum concerning the above subject from your office.

The following information in this memorandum was obtained from the Corps of Engineers, NED on April 10, 1957, and security clearance for the information was obtained through Major Harris. Investigations are currently being made at Dow AFB, and I will make a subsequent followthrough of a field inspection as soon as possible. The information that follows is as correct as the records that were available to me.

Loring Air Force Base

1. Flexible pavement: 1,203,767 square yards.
   (*a*) This area includes runway, principal taxiways, aprons, blast pads, stubs, and shoulders for taxiways.
   (*b*) The various phases of pavement construction vary slightly in design, but the bulk of the construction is as follows:
      (1) 3 inches asphaltic concrete.
      (2) 9 inches dry bound crushed stone base.
      (3) 60 inches sand and gravel subbase.
2. Rigid pavement: 321,766 square yards.
   (*a*) This area includes ends of runways, aprons, hardstands, and stubs.
   (*b*) The pavement construction is as follows:
      (1) 15 inches portland cement concrete.
      (2) 52 inches to 55 inches sand and gravel base and subbase.
3. Pavement performance.
   (*a*) The rigid and flexible pavements mentioned above were designed for B–36 loads but receive B–52 loads at this time.
   (*b*) No distress has been experienced with the asphaltic pavements, but some damage has developed from jet fuel spillage. The jet fuel damage has been corrected by seal coats of coal tar pitch emulsions.
   (*c*) No distress has been experienced with portland cement concrete pavements. Some scaling or flaking of the surface has occurred because of the use of de-icing salts and freezing and thawing cycles. Joint maintenance has been a problem.

Westover Air Force Base

1. Flexible pavement—814,050 square yards.
   (*a*) This area includes runways, taxiways, shoulders, and overlay on World War II soil cement aprons.
   (*b*) The various phases of pavement construction vary slightly in design, but the bulk of construction is as follows:
      (1) 2 inch to 4 inch asphaltic concrete (majority 4 inches)
      (2) 5 inch to 6 inch dry bound and graded crushed stone base (majority 6 inches)
      (3) 4-inch gravel base
2. Rigid pavement: 814,800 square yards.
   (*a*) This area includes runway ends, taxiways, and aprons.
   (*b*) The various phases of pavement construction vary slightly in design, but the bulk of construction is as follows:
      (1) 6 inch to 15 inch portland cement concrete (majority 15 inches)
      (2) 8-inch gravel base
3. Pavement performance
   (*a*) The above-mentioned rigid and flexible pavements were designed for World War II loads, but they received B–52 loads at this time.
   (*b*) Both rigid and flexible pavements are rated as good to excellent.

Portsmouth Air Force Base

1. Flexible pavement—533,910 square yards.
   (*a*) This area includes taxiways and blast aprons.
   (*b*) The construction is as follows:
      (1) 4 inches asphaltic concrete
      (2) 6 inches crushed stone
      (3) 8 inches gravel
      (4) 30 inches sand
2. Rigid pavement—1,504,078 square yards
   (*a*) This area includes the runway, taxiways, and aprons.
   (*b*) The pavement construction is as follows:
      (1) 14 inches portland cement concrete
      (2) 8 inches gravel
      (3) 26 inches sand
3. Pavement performance
   (*a*) The above-mentioned rigid and flexible pavements were not designed for but do receive B–52 loadings.
   (*b*) Both rigid and flexible pavements are rated as excellent. The rigid pavement slabs have displaced, and some rough riding qualities exist.

Dow Air Force Base

1. Flexible pavement, 203,450 square yards:
   (*a*) This area includes light duty flexible pavement, flexible pavement transition, shoulders, and blast aprons.
   (*b*) The various pavement thicknesses are as follows:
      (1) Light duty flexible pavement:
         (a) 3 inches asphaltic concrete;
         (b) 6 inches crushed stone base;
         (c) 19 inches sand and gravel subbase.
      (2) Shoulder pavement:
         (a) 2 inches asphaltic concrete;
         (b) 6 inches select sand and gravel base;
         (c) 10 inches sand and gravel subbase.
      (3) Blast apron pavement:
         (a) 2 inches asphaltic concrete;
         (b) 6 inches select sand and gravel base.
2. Rigid pavement, 482,100 square yards:
   (*a*) This area includes the following:
      (1) Heavy load type A traffic—runway ends, aprons, taxiways (58,400 square yards).
      (2) Heavy load type B traffic—runway ends, aprons, taxiways (109,000 square yards).
      (3) Heavy load type C traffic—runway interior (314,700 square yards).
   (*b*) The various pavement thicknesses are as follows:
      (1) Heavy load type A traffic:
         (a) 21 inches portland cement concrete,
         (b) 6 inches select sand and gravel base,
         (c) 27 to 29 inches select sand and gravel subbase;
      (2) Heavy load type B traffic:
         (a) 19 inches portland cement concrete,
         (b) 6 inches select sand and gravel base,
         (c) 27 to 29 inches select sand and gravel subbase;
      (3) Heavy load type C traffic:
         (a) 17 inches portland cement concrete,
         (b) 6 inches sand and gravel base,
         (c) 27 to 29 inches select sand and gravel subbase.
3. Pavement performance:
   (*a*) The flexible and rigid pavements mentioned above were designed for B–52 loads, but the recent construction has not yet received any traffic.
   (*b*) The flexible pavements are rated as excellent, and the rigid pavements are rated as fair because of recent displacement and cracking. The rigid pavement failures are believed to be caused by border line base and subbase material that evidently was frost susceptible.

DOW AIR FORCE BASE

From Robert C. Briggs, district engineer, the Asphalt Institute, Boston 16, Mass., April 24, 1957

This memorandum is to advise you of my findings at an inspection of Dow Air Force Base on April 17, 1957. The comments made in this memorandum are in addition to information given in a memorandum dated April 12, 1957.

By coordinating with the Corps of Engineers at Dow Air Force Base, I was able to get security clearance through the Air Force to make an inspection of the pavements presently existing at the airfield. The pavements include asphaltic concrete, tar rubber concrete, and portland cement concrete. The parking areas are generally tar rubber concrete. The old runway is asphaltic concrete. This runway has received some heavy bomber loadings, but no rutting has occurred from channelized traffic and the surface is in excellent condition. The tar rubber parking areas are in good condition with the exception of construction joints. A great deal of difficulty has been encountered in handling tar rubber, and I have noted that most of the construction joints crack, ravel, and open up.

New taxiways, aprons, and a new parallel runway have been recently constructed or are in the process of being constructed with portland cement concrete. Most of the aprons and taxiways are completed, but the new runway is only partially completed. My previous report on airfields indicates the thick-

ness of portland cement concrete used. Failure of the portland cement concrete has occurred during this winter without having received any traffic. It is believed that the failure is due to frost susceptibility of base material that was considered borderline quality. The material was approved by the Corps of Engineers for base material with the realization that relatively close material inspection would have to be made so that the material did not fall within a frost susceptible range. Some of the material evidently was frost susceptible and cracking and displacement of the concrete slabs occurred. This is of considerable concern to the Corps of Engineers and the Air Force, and I have learned from secondhand information that numerous investigations and conferences have been held. It is hard to estimate the amount of cracking that I saw, but as an estimate I would say that about 2 to 5 percent of the concrete slabs failed. I noted that investigations were in progress to test the base material.

Because of the short time that I had available in preparing for my trip to Dow Air Force Base, I was unable to take photographs of the pavement areas.

Kelly Air Force Base Test Section

From Charles A. McKeogh, district engineer, the Asphalt Institute, New Orleans 18, La., April 11, 1957

I received some very interesting information concerning the Kelly Air Force Base test section from the Waterways Experiment Station on April 3, 1957.

You will recall that the asphaltic concrete surface course had been removed by a blade, and the section resurfaced with a mix similar to the mix used to surface the runway. The binder course was not removed.

A recent inspection of the resurfaced test section by the Waterways Experiment Station reveals that there are no signs of pavement failure or displacement after the 9 months of continuous use by B–52's, B–47's, and other heavy aircraft.

Information on Airfields

(Report from C. A. McKeogh, district engineer, the Asphalt Institute, New Orleans, La., April 19, 1957)

Kelly Air Force Base test section (heavy-bomber base)

The 1½-inch surface course of the test section was removed and replaced with a surface course mix similar to that placed on the runway. A recent condition survey by the Corps of Engineers, Waterways Experiment Station, reveals there is no pavement failure or displacement after 9 months of continuous use by B–52's, B–47's, and other heavy aircraft.

Kelly Air Force Base (heavy-bomber base)

The heavy-duty runway is 10,800 by 300 feet, 8,800 feet is 4 inches of hot-mix asphaltic concrete, the 1,000-foot ends are 18-inch portland cement concrete with the 75-foot width center lanes 20 inches portland cement concrete. The runway was completed in May 1956 and has given excellent service since that date. The primary and connecting taxiways are concrete, and the apron is concrete.

The original contract was for asphalt taxiways, with some asphalt overlay. The original hot-mix tonnage was approximately 138,000 tons, the change to portland cement concrete taxiways reduced the hot mix to 92,000 tons (runway and shoulders) and increased the portland cement concrete from 240,000 cubic yards to 330,000 cubic yards. The change increased the total contract over $600,000. I believe that a part of the $600,000 (plus) included an extension of the apron.

(Note: Bid prices are being obtained from the contractor—see exhibit E–4.)

The asphaltic concrete runway is in good condition, no reported pavement failures, after 10 months of service. The asphalt pavement is exceptionally smooth according to a survey made by the Waterways Experiment Station.

Abilene Air Force Base (heavy-bomber base)

The heavy-duty runway is hot-mix asphaltic concrete with 1,000-foot ends of portland cement concrete, all taxiways are asphalt. The apron is portland cement concrete. Alternate bidding, with asphalt low by more than 15 percent. There was an attempt to change the pavement at this base to all portland cement concrete. The contractor made a rough estimate of $350,000 to $400,000 to make the change. After some discussion it was decided to construct the pavement as originally planned.

This is a B–47 base and has above the average takeoff and landing cycles as it is now being used to train B–47 pilots.

This pavement has been subjected to continuous use since the latter part of 1953 or the early part of 1954. The pavement is in good condition as there is no sign of failure or displacement. A recent condition survey does note parallel cracking at each end of the runway 20 to 30 feet from the edge of the pavement. Waterways Experiment Station is at present unable to arrive at a reason for the cracks, but believes that they are from the crushed stone base course, possibly along a construction joint. The cracks are not in the asphaltic concrete construction joints. The paving engineer on the job stated that some difficulty was experienced in setting up the base on the south end, east side of the runway, and that the base in this area contained excess moisture. Cracks were noted in this area. There was no displacement of the pavement in these cracked areas.

The joint sealing material in the portland cement concrete apron joint is failing (noted 6 months ago) and it will be necessary to reseal the joints. Portions of the apron where the sealing material is failing are less than 14 months old.

A profile of the portland cement concrete apron revealed that in some areas, especially along the edge, the vertical joint displacement was ⅜ inch to 1 inch, with some displacement reported to be 1½ inches.

Carswell Air Force Base (heavy-bomber base)

A heavy-duty taxiway, designated as taxiway H was constructed in 1952. Alternate bids were taken, with asphalt low by more than 15 percent. This taxiway has been in continuous use since early 1952, and has a good service record. There were two small areas reported as failures in 1953. A condition survey was made and it was found that the reported failures were at two CBR test locations. The two areas were repaired and there has been no report of any failure since that time. This taxiway has been subjected to an excessive amount of heavy concentrated traffic.

In 1954, a 3,000-foot runway extension with taxiway was let with alternate bids, as follows:

Runway:	Taxiway:
1,000-foot portland cement concrete, 2,000-foot asphalt, or 3,000-foot portland cement concrete	Asphalt, or portland cement concrete

The asphalt alternate was low by more than 15 percent. The bid was rejected and the job readvertised as follows:

Runway:	Taxiway:
Portland cement concrete	Asphalt
Portland cement concrete	Portland cement concrete

Again the asphalt alternate was approximately 15 percent lower, which was an all portland cement concrete runway with an asphalt taxiway.

Little Rock Air Force Base (heavy bomber base)

10,000-foot runway, 8,000- by 200-foot asphaltic concrete, 1,000- by 200-foot ends portland cement concrete, 1,500- by 75-foot asphalt taxiways. Heavy duty pavements, 4-inch asphaltic concrete. The apron is portland cement concrete. The pavement was completed about June 1955 and has been used as a B–47 base.

Immediately after completion of the airfield pavement a B–47 formed ruts in a portion of a taxiway. An investigation revealed that this area had been condemned because of excessive moisture in the base; after some debate the wet area was paved. It was subjected to B–47 traffic almost immediately after the pavement was completed. Necessary repairs were made, and there has been no report of failure to date. Reports indicate that the asphalt pavement is performing satisfactorily.

The joint sealing material in the joints of the portland cement concrete apron was declared a failure 18 months after completion of the pavement. A portion of the joint sealing material was removed and replaced at a cost of $100,000 or approximately 40 cents per linear foot of joint. (All costs are approximate.)

The Little Rock Air Force Base was an alternate bid job, the asphalt alternate was 15 percent lower than all portland cement concrete.

Lake Charles Air Force Base (heavy bomber base)

All airfield pavement is 17-inch portland cement concrete, with asphaltic concrete shoulders. The asphaltic concrete was recently completed, January 1957.

Reports on the condition of the pavement indicate a continuous deterioration of the portland cement concrete taxiway. Cracks form along the centerline of the pavement, and spalling occurs when the cracked areas move under load.

No one will definitely state that the pavement is a failure, but all are concerned about the cracking and spalling along the centerline of the taxiway pavement. The above described pavement condition was obtained from Galveston District personnel. No alternate bids were taken for this job.

Albuquerque Air Force Base (heavy bomber base)

The runway is asphalt with 1,000-foot concrete end, the runway is 13,000 by 300 feet. The asphaltic concrete is 4 inches thick. The taxiway is a 4-inch asphaltic concrete overlay on an old asphalt runway. The asphaltic concrete pavement was completed about May 1954.

There was no alternate bid as asphalt was cheaper than portland cement concrete by more than 20 percent.

The asphaltic concrete has been subjected to all types of aircraft from light to the heaviest wheel load. It is used for transient military aircraft flying across country and also as a commercial airfield. The air traffic is considered above normal. The asphaltic concrete pavements have given good service and there has been no report of pavement failure.

Altus Air Force Base (heavy bomber base)

The original pavement was all asphaltic concrete, constructed in 1953. A pavement failure on the apron was reported a year later. During this period of 1 year the pavement had been subjected to 100,000-pound wheel loads, but failed when subjected to the B–47 wheel load. Failure occurred in the subbase, a material with a high PI which was salvaged from an old runway base constructed in 1942. During construction of the base course an excessive amount of water was used to maintain and set up the sand and crushed granite base course. It is the writer's opinion that the failure was "built in" during construction, and that failure would have occurred only in isolated areas. This belief was shared by others as it was estimated that the apron could be repaired and placed in good condition for a cost estimated at $50,000. Recently the apron was paved with portland cement concrete, costing over $3 million.

Six months ago the writer made an inspection of the runway and taxiways. The original asphaltic concrete was still performing satisfactorily and there has been no report of failure. The runway and taxiways have been subjected to B–47 traffic since 1954. The runway recently received an emulsion-sand seal coat. There were some cracks along the edge of the runway, which were sealed by the seal coat application. No new repair was noted on the taxiways. The taxiway with 5 inches of asphaltic concrete is in excellent condition. Reports indicate that this taxiway has been subjected to 90 percent of the heavy aircraft traffic operating at this base.

Biggs Air Force Base (heavy bomber base)

Asphaltic concrete runways, taxiways and parking apron. There were no alternate bids as asphalt paving cost estimates were more than 20 percent lower than portland cement concrete. These pavements were constructed in 1953. The runway pavement has given satisfactory service, and there have been no reported failures. There was a report of rutting of the pavement on a taxiway that had been overlaid with 4 to 6 inches of asphaltic concrete. The actual cause of the rutting is not known to the writer, but during an inspection of the project it was noted that the binder course contained excess asphalt. This condition was corrected. It is believed that the rutting was in isolated areas, as a result of excess asphalt in the binder course.

The report of apron pavement failure investigated by the writer, concerned motor oil drippage and/or spillage on the apron asphalt pavement. The motor oil softened the pavement, and had a very detrimental effect on the pavement due to very slow evaporation. The pavement would remain in a very soft condition for several days. The soft areas were not in the line of aircraft movement so pavement damage was the result of service equipment traffic. There was no visible damage by the spillage of aviation gas or jet fuel.

I know of no major repair of the pavement at this base, and to the best of my knowledge the pavement service has been considered satisfactory.

Barksdale Air Force Base (heavy bomber base)

All portland cement concrete, no alternate bids were advertised. It has been reported that the joint sealing material has failed at this base, so it can be assumed (there are no actual reports) that the joints are uneven.

Walker Air Force Base (heavy bomber base)

Runway: Asphaltic concrete overlay, and extension with 1,000 feet portland cement concrete ends. Constructed 1954–55.

Taxiways: Asphaltic concrete overlay. Constructed 1953.

No alternate bids requested as cost of asphaltic concrete was more than 20 per cent cheaper than portland cement concrete. Recent airfield pavement construction has been portland cement concrete. There were two reported pavement failures at this base, both concerned the taxiway overlaid in 1953.

1. The first report was settlement at the juncture between the asphaltic concrete overlay pavement and a previously constructed portland cement concrete parking area. This settlement was apparently caused by lack of compaction during backfilling a narrow trench between the newly constructed portland cement concrete pavement and the old asphalt taxiway pavement.

2. Rutting of the taxiway overlay asphaltic concrete pavement was reported 1 year after completion. A 2-inch overlay had to be placed on a 2-inch asphaltic concrete pavement built in 1943. During the period of 1943–48 two seal coats had been applied. Sections sawed from the rutted areas showed that the newly placed overlay pavement maintained a uniform 2-inch thickness across the rut and the full width of the channelized traffic lane. The pavement constructed in 1943 consolidated under the traffic to a depth equal to the depth of the rut.

A recent reported failure was the consolidation of the tar-rubber pavement. Depressions of three-eighth inch were noted in areas where heavy aircraft are parked for maintenance. The reported failure represents only a small portion of the entire area of asphaltic concrete pavement. I do not know of any major airfield pavement repair on this base. The taxiways, except for the overlaid taxiway pavement, have given good service under continuous heavy bomber traffic. The asphaltic concrete runway pavement has been in continuous use since completion and the service record of this pavement is good.

During a recent visit to this base, by the writer, it was noted that the 2-inch asphaltic concrete shoulder pavement was being subjected to as many aircraft traffic passes as the newly constructed portland cement concrete taxiway pavement.

Bergstrom Air Force Base

The service record of the asphaltic concrete runways and taxiways, at this base, is amazing. The pavements are light duty or 25,000 pounds, 200 p. s. i. tire pressure design. Immediately after completion of the pavement the base was transferred to SAC. Reports indicate that traffic is above normal and that not less than one-half of the aircraft traffic has been heavy bomber aircraft. There has been no report of any type of pavement failure, and these light duty pavements have given satisfactory service although subjected many times to heavy bomber loads.

Trench-type construction was not used for construction of this pavement. The subbase was full width, with the crushed stone base course sloped to a point approximately 20 to 25 feet beyond the edge of the pavement.

Alexandria Air Force Base

All portland cement concrete. In 1955 a contract was let for an asphaltic concrete overlay to increase the pavement strength. At the last moment, the flexible overlay was changed to a portland cement concrete overlay; this change cost an additional $300,000. The 9-inch overlay thickness varied to as much as 17 inches in some areas, 11-inch overlay on the ends of the runway with an overall average of 13 inches. Based on past experience, it is believed that the irregularity of the existing portland cement concrete would surely result in a cracked irregular surface of the new pavement soon after being subjected to traffic. The type of aircraft at this base is unknown. (See exhibit E–4.)

Laredo Air Force Base

Light duty—25,000 pound, 200 p. s. i. tire pressure. Parallel runways and taxiways are 3-inch asphaltic concrete. Constructed 1952–53. Above normal traffic, 1,800 cycles per day. No failures reported, no fuel spillage damage, no blast damage. Good service record. Asphalt cost 20 percent lower.

Laughlin Air Force Base

Light duty—25,000 pound, 200 p. s. i. tire pressure. Parallel runways and taxiways are 3-inch asphaltic concrete. Constructed 1952–53. Above normal traffic of more than 1,800 cycles per day. No failures reported, no fuel spillage damage, no blast damage. Good service records. Asphalt cost 25 percent less than portland cement concrete.

Perrin Air Force Base

Light duty—25,000 pound, 200 p. s. i. tire pressure. Asphaltic concrete runways and taxiways. Constructed 1952–53. Above normal traffic. Good service record. No failures reported. Asphalt cost 20 percent lower. No fuel spillage or blast damage. It was recently reported that all joint sealing material had failed in joints of newly constructed portland cement concrete apron. Request was made to reseal all joints.

Big Spring Air Force Base

Light duty—25,000 pound, 200 p. s. i. tire pressure. Three-inch asphaltic concrete runways and taxiways. Constructed 1951. Above normal traffic. Good service record. No failures reported.

Air Force personnel applied seal coat in 1954. Excessive amount of asphalt used. Pavement did not need seal coat.

Sheppard Air Force Base

Light duty—25,000 pound, 200 p. s. i. tire pressure. Asphaltic concrete runway and taxiways. Good service record, average traffic. Constructed 1952–53. Cracks were reported along edge of pavement in 1955.

Hearne Air Force Base

Light duty—25,000 pound, 200 p. s. i. tire pressure. Three-inch asphaltic concrete runway, taxiways, and apron. Constructed in 1954; average traffic. Auxiliary for Bryan Air Force Base. No failures, good service.

Harlingen Air Force Base

Light duty—25,000 pound, 200 p. s. i. tire pressure. Flexible overlay over 6-inch portland cement concrete pavement. Average traffic. Good service record. No reported failures, constructed 1954–55.

Amarillo Air Force Base

Light duty—25,000 pound, 200 p. s. i. tire pressure. Three-inch asphaltic concrete maintenance apron. Constructed 1951. No reported failures. Cracks noted in pavement in 1953, believed to be dry weather drought cracks.

Reese Air Force Base

Light duty—25,000 pound, 200 p. s. i. tire pressure. Constructed in two phases. In 1951 the old asphaltic concrete pavement was broken up, sand added to highly plastic base course, and recompacted. A 2-inch asphaltic concrete was placed to provide temporary runways for 2 years. Drainage was very poor. Pavement cracks appeared after a flight of B–29's used the runway, July 1952. There was no pavement deformation or displacement and there were no repairs made until the runways were rebuilt in 1954. The runway was in continuous use during the period July 1952–54.

The runways were reconstructed in 1954 with 3 inches of asphaltic concrete. The pavement has a good service record and there are no reports of failure. Above normal traffic. Auxiliary fields—San Angelo (Van Court) and Colorado City, all asphaltic concrete. Good service records. No reports of failure.

Gray Air Force Base

Asphaltic concrete runways, taxiways, and apron. Constructed in 1952. Four-inch asphaltic concrete. No information available, very restricted. Traffic unknown, wheel load unknown. No report of failure, service record good.

EXHIBIT D–1

STATEMENT BY ARVIN S. WELLBORN, CHIEF ENGINEER, THE ASPHALT INSTITUTE, APRIL 11, 1956

The decision of the Air Force to curtail construction of asphalt pavements on military airfields was based on alleged pavement failure at 7 heavy bomber bases, 2 of these in California, 2 in Arizona, 2 in Oklahoma, and 1 in Florida.

With the permission of the Department of Defense, these bases have been inspected by engineers of the Asphalt Institute. Preliminary appraisal of the inspection reports indicates that, in every instance, pavement distress was caused by the displacement of supporting foundation materials. The reports also show:

(*a*) Air Force criticism of asphalt pavement has been unduly harsh,

(*b*) Serious pavement distress was found at only 2 of the 7 bases in question,

(*c*) Pavement maintenance at these military airfields continues to be haphazard or seriously neglected, and

(*d*) There is a definite need for heavier airfield pavement design and improved construction methods to accommodate America's heavy bombers.

The reports, covering inspections made at all seven bases, included these preliminary findings:

None of the four bases in California and Arizona showed a condition of pavement distress serious enough to impede normal operational activities.

At 1 of the 2 bases in Oklahoma the reports showed evidence of serious rutting which could be traced directly to displacement of foundation materials beneath the pavement. At the other Oklahoma base, heavier aircraft have not been operated extensively on the pavement and, of course, there is no evidence of distress.

The seventh base, in Florida, has developed dips in the pavement at approximate 100-foot intervals along the centerline of the runway, causing the aircraft to "porpoise" at high speed. Again, the fault is clearly in the foundation.

In every instance, the institute inspection confirmed the findings of a special committee of the Highway Research Board which, at the request of the Department of Defense, made an extensive study in 1955 of pavement conditions at 27 major military airfields. On that occasion, the committee reported a serious lack of proper airfield maintenance at virtually all installations. The reports of the engineers of the Asphalt Institute find this condition still existing.

The reports pointed up one disquieting feature that suggests a revision of airfield pavement design may be in order. Present design criteria are based on the assumption that aircraft movements will be distributed over the entire width of taxiways and runways. However, heavy bomber traffic, instead of being so distributed, is channelized along the centerline. A rising volume of traffic and steadily increasing wheel loads, coupled with this channelization, has established a pattern of pavement stress which calls for heavier pavement design to carry this narrow concentration of loading. This channelization of heavy wheel loads is resulting in accelerated attrition of all airfield pavements, regardless of type.

The reports indicate there is a definite need, not only for heavier design, but also for better construction methods for all heavy bomber airfield paving, with particular attention to the need for better foundations and proper drainage.

With necessary attention to these requirements, there is not the slighest doubt that asphalt pavements will meet all airfield runway and taxiways needs, and do the job at tremendous savings to the taxpayer.

INFORMATION DEVELOPED BY INSPECTION OF SEVEN AIR FORCE BASES BY ASPHALT INSTITUTE ENGINEERS IN FEBRUARY–MARCH 1956

(Supporting documents available)

1. Pinecastle Air Force Base, Orlando, Fla.

Inspection by Asphalt Institute engineers found depressions at regular 100-foot intervals down the centerline of the runway which caused aircraft to "porpoise" at high speeds. A preliminary evaluation report performed by the Corps of Engineers disclosed that blue top stakes were found in place when exploratory pits were dug at original depression points. Presence of these stakes indicated that there had been no compaction of the base materials

where these stakes were found. Leaves and other debris were found packed loosely around the top stakes, suggesting that rollers had executed figure eights around the top stakes during base construction, leaving uncompacted areas at these regular 100-foot intervals prior to placement of the pavement. Settlement of the pavement was inevitable.

2. Tinker Air Force Base, Oklahoma City, Okla.

Inspection at this field revealed no failures or signs of distress in the existing pavement. Main concern stemmed from a letter, written by the Tulsa district office, Corps of Engineers, restricting loading of the new runway to 75,000-pound gear loads pending further investigation. During construction, one or more B–47's traversed the binder course, causing some rutting. Contractor expressed belief that rainwater had ponded on the binder course during the construction period, dammed by the higher elevation of the adjacent surface course. This water, filtering through the binder course, had softened the base or subbase causing base failure in this area. An area 15 feet by 60 feet was removed and replaced.

3. Altus Air Force Base, Altus, Okla.

Investigations at this base developed the fact that pavement distress could be traced directly to inadequate base and subbase construction. In both courses, a crushed granite material of low bearing stability and very high plasticity index was used. It was the opinion of inspectors that material of greater bearing stability should have been mixed with the crushed granite, and the foundation courses should have received additional compaction to prevent deflection under heavy load traffic. It is significant that taxiway No. 2, which handles a heavier concentration of aircraft traffic than any other area on the base, is showing no distress. The lower courses of this taxiway were used as a haul road by construction traffic while the runway was being built, giving it the "proof rolling" needed. Also, an additional 2 inches of asphaltic concrete surface pavement were added to the specified 4 inches during construction to take care of grade line changes, furnishing added pavement strength.

4. Williams Air Force Base, Phoenix, Ariz.

Interviews with base personnel revealed that the most serious and immediate problem was presented by the tar-rubber parking apron which had become brittle and developed shrinkage cracks which admitted spilled jet fuel into the asphaltic concrete beneath. The apron surface had become so brittle that the slightest force caused it to spall and the loose particles had become a menace to jet engines.

In 1955 there were approximately 344,000 landings at Williams Air Force Base. This figure was expected to increase in 1956. The base commander stated that the new primary parallel (outer) asphalt runway had performed in an excellent manner. The portland cement ends on this runway are considered to be much rougher than the asphaltic concrete. The portland cement concrete inner runway was considered quite rough by all pilots interviewed. The amount of curling in the old slab has required that some be removed and replaced.

While no water puddles on the asphaltic concrete runway, puddling of rainwater on the portland cement concrete runway affects the proper operation of the nose wheel of the T–33 aircraft.

5. Castle Air Force Base, Merced, Calif.

There is some settlement of flexible pavement adjacent to the portland cement concrete slab. However, these areas are isolated; they are not operational problems and little maintenance has been necessary. There is evidence on the runway that the mixture is overrich in asphalt in sections, but there was no evidence of instability in the asphaltic concrete due to excess asphalt.

The runway to one side of the centerline is smoother than the other side. There is one major local depression about 6,800 feet from the southeast end of the runway, approximately 100–150 feet long, 25–30 feet wide, and with a maximum depth of 3 inches. Pilots say the bump is severe but not getting any worse. The experienced pilots stay to the right of the centerline to avoid the bump and do not regard the runway as hazardous.

Irregularities observed in the runway seem to have been built in during construction. This may have been due to the fact that little, if any, leveling was done prior to the permanent resurfacing of the runway in 1954.

It was recommended by our engineers that this 3-inch depression 6,800 feet from the southeast end of the runway be corrected immediately if it was causing a serious problem. We were informed several days later that, after due deliberation, the base had decided to postpone corrective work on the depression until some later date when a larger project involving the correction of several high and low spots on the runway could be corrected at the same time.

6. Davis-Monthan Air Force Base, Tucson, Ariz.

The flexible pavements at this base appeared to be structurally sound, with these exceptions:

(*a*) Taxiway 14 where there is centerline cracking and engineering confirmation of construction with an unstable pavement mix. This is supported by visual evidence of pavement bleeding. An analysis of traffic indicated that the heavy-duty flexible pavements at this base already had carried a greater volume of traffic than they had been designed and built for.

(*b*) Serious blast damage at extreme ends of the runway where replacement with portland cement concrete is clearly indicated.

(*c*) Bumps on taxiway 14 where asphalt patching has been used to seal investigative trenches. It appears that the backfill in these trenches was not properly consolidated at the time of construction and this condition has not been corrected. Pavement settlement followed settlement of the fill material. It was the consensus of the B–47 pilots that there was nothing particularly serious about this taxiway condition; they simply slow their aircraft approaching these bumps. If this condition were regarded as a serious operational hazard, it would seem that the aggravated condition should not have been permitted to persist as long as it has.

The commanding general of the 36th Air Division was strong in his expressed preference for portland cement concrete paving. The commanding officer of the 303d Bomb Wing also was sharply critical of flexible asphalt pavements. He attributed the "porpoising" of B–47 aircraft to deformations in the asphalt runway.

Major Nix, a B–47 commander, doubted that pavement condition could be assigned the principal blame for aircraft porpoising. He suggested the tendency may be inherent in the plane's design. Such things as shifting of the center of gravity under different loading conditions might cause it. He also pointed out that pilot technique could have something to do with it. A jarring landing has a tendency to start the porpoising action, he said, or landing heavily on the nose wheel.

B–47 aircraft parked for long periods on an old and abandoned asphalt runway have broken through the pavement. The commanding general cited this condition in his criticism of asphalt pavements. The old runway, actually, was not designed to sustain these loads and when it was resurfaced the original base weakness never was corrected. From visual inspection the new surface and maintenance mix did not appear to be the dense and stable mix that would be required to improve the load-bearing capacity of the pavement.

7. March Air Force Base, Riverside, Calif.

A temporary taxiway extending from the southeast end of old runway No. 4 to taxiway No. 11 showed signs of settlement failure after 7 months of use. This taxiway is not part of the permanent field installation but was built by the contractor in 1945 to expedite his work in other areas. Failures in taxiway No. 11 (now designated taxiway No. 3) were investigated in June 1954. This taxiway was built between July 1951 and May 1952 with 4 inches of asphaltic concrete on 7 inches of dry-bound macadam, on 6 inches of compacted pit run gravel, on 14 inches of compacted disintegrated granite, over compacted native soil.

Depressions in the taxiway were first noted about April 1, 1954, at which time the depressions were comparatively small and settlement did not exceed 1 inch. In a 2-month period the deterioration was rapid, and advanced to such a point as to cause the investigation of June 1954. The conclusions from the investigation were that failure occurred in the native subsoil below the depth affected by construction operations. The settlement was attributed largely to consolidation of the native soil, brought about by heavy and sustained localized traffic and increased moisture content due to heavy winter rains. Failure extended 5 to 6 feet on either side of the centerline and extended intermittently for almost the entire length of the taxiway. Maximum settlement was approximately four-tenths of a foot from the profile grade. Asphaltic concrete was used to fill the

rut and a 1½-inch asphaltic concrete overlay was placed on the center 40 feet of the taxiway.

Additional settlement failure was evident on taxiway No. 11 (now No. 3) since the area was repaired in 1954. The new failed area was 6 feet on either side of the centerline for a distance of 400 feet.

SUMMARY

The four bases in division V (those in California and Arizona) have no failure of such magnitude as to be critical to the operational facilities of the base. Although some pilots believe that roughness of paved surface is harmful to their electronic equipment, no single instance can be shown where there has been improper functioning of electronic equipment that was caused by pavement condition.

With the exception of one surface irregularity at Castle Air Force Base and the condition of Pinecastle Air Force Base, there was no outstanding condition to which porpoising of the B–47 aircraft could be attributed. Surface maintenance has been seriously neglected at all these bases. It appears that inspection during construction has been highly inadequate. There is evidence that testing of materials has been inadequate if not lacking entirely. This point is borne out by the incorrect reporting of CBR (California bearing ratio) values at Pinecastle Air Force Base and the high plasticity index materials at Altus Air Force Base.

Drainage seems to be neglected at all bases.

Summary Report on the Status of Flexible Pavements for Heavy Military Aircraft

By Arvin S. Wellborn, Chief Engineer, The Asphalt Institute

PREFACE

In recent weeks, elements of the engineering press, armed with insufficient information, have attempted to appraise the status of flexible pavements for modern mililtary airfields. These appraisals have been based on incomplete data from a single pavement test conducted during the summer of 1956 at Kelly Air Force Base in Texas.

It is the considered judgment of the Asphalt Institute, after an extensive review of all the facts, that the tests at Kelly AFB could have ended no other way than distress in the asphalt section. A combination of factors, readily understood by asphalt technologists, doomed the pavement to failure before the first test loading was placed on it.

Further, since the suspension of testing at Kelly, new pavement test loading conditions have been established that are totally unprecedented in the history of pavement design. In fact, the new conditions have removed pavement design entirely from the realm of contemporary paving technology and placed it in a new and uncharted dimension.

It must be borne in mind that flexible pavements today are serving fully the requirements of our heaviest bomber aircraft at many Air Force installations. Consequently, we must apply very critical judgment to the results of the Kelly test and ask: Why failure here?

Because the accounts of the Kelly AFB test have lent themselves to gross misinterpretation, seriously injuring the reputation of all flexible pavements, this engineering examination of the situation must be offered.

HISTORY

Some elements in the Air Force long have expressed dissatisfaction with flexible pavement and, in 1954, announced they were specifying concrete paving for those "critical" areas subject to jet afterburner blast and excessive fuel spillage which might have a harmful effect on asphalt pavements. In December of 1955, the Secretary of Defense authorized the Air Force to extend the term "critical" to include all "primary use areas," including those areas not subject to this spillage and heat blast. In defense of its new policy, the Air Force claimed failures in flexible pavements wherever the channelized traffic of the new B–47 bombers was applied. Seven heavy bomber bases were cited where such failures were alleged to have occurred.

Granted permission to inspect these fields, the Asphalt Institute determined that only 3 of the 7 airfields showed distress that could not be corrected with

normal maintenance procedures. In the three cases of severe distress the cause was traced to faulty design or construction. In one instance elementary drainage had been largely neglected. At another base, it was learned that distressed areas had not been compacted before paving. In only one case was the distress traced directly to the asphaltic concrete surface and in this instance the pavement did not meet the design requirements. In most cases, proper maintenance operations were virtually nonexistent.

The United States Corps of Engineers expressed their confidence that asphalt pavements are entirely capable of withstanding the channelized traffic and supported this position with data from test panels constructed at their Flexible Pavements Branch at Vicksburg, Miss. The Air Force declined to accept this as conclusive evidence and requested that a demonstration-type section be constructed under normal contract conditions. Kelly Air Force Base was selected.

Existing criteria were applied to the test sections, except that the test loading requirements were increased from 1,500 to 30,000 coverages of 100,000-pound dual-wheel loads under accelerated traffic and at pavement temperatures in excess of 90°F. (It should be noted that this increase in coverages was a twenty-fold increase at high temperatures for flexible pavement. At the same time the increase in coverages for the rigid section was only sixfold.)

During the construction of the pavement, it became apparent to the Asphalt Institute, serving as an observer, that the paving mix required by Air Force mandate was clearly too rich to sustain the accelerated test traffic immediately after construction, in the midsummer Texas heat. An experienced asphalt technologist knows how an overrich asphalt mix will behave.

When the institute's worst fears were realized and the pavement showed early distress, the asphalt industry proposed that the faulty test section be removed and reconstructed with a more appropriately proportioned mixture. The Air Force declared itself satisfied with the results and ordered the tests terminated—although normal procedure by experienced engineers under these circumstances would have been to modify the mix, making it leaner, and retest.

ANALYSIS OF THE TEST

For reasons not entirely clear, the test called for 30,000 coverages at accelerated rate of the 100,000-pound gear load at pavement temperatures not lower than 90°F.—although it is apparent that these extreme conditions will never be encountered in actual airfield operations. The existing mix design criteria then in use by the Corps of Engineers called for 1,500 coverages of accelerated traffic under high pavement temperatures. Pavements designed by these criteria are today carrying heavy bomber traffic without distress.

The decision to step up the tempo of the accelerated traffic in the hottest summer months must be recognized as an unrealistic requirement. This accelerated traffic coverage was scheduled at a rate of 500 coverages per day which is the equivalent of a full month's usage of the pavement under prototype traffic. To withstand this type of testing it is only logical that the asphalt mixture should have been designed with a proportionately leaner asphalt content. This was recognized by the Corps of Engineers. However, they were not given the opportunity to adjust the mix and retest.

Let us summarize the curiously mixed factors that were jammed into the test equation:

1. The Air Force required the asphalt pavement to be designed on the basis of criteria established with 1,500 coverages of accelerated test traffic at high temperature.

2. Test traffic applied at Kelly, however, was 30,000 coverages, or 20 times the amount on which the pavement mix design criteria were based.

3. All test traffic was applied at Kelly under high pavement temperature conditions, a situation not encountered in actual airfield pavements. As any technologist knows, this is abnormally severe for asphalt pavement and not similarly severe for rigid pavement.

4. Spacing of test traffic load wheels was 20 feet instead of approximately 40 feet, as for the B–47 aircraft. This factor may have eliminated for all practical purposes rebound and recovery factors and induced interfacial stresses of a high order of magnitude.

5. So-called antistrip additive was placed in the hot asphalt mixture. This procedure is contrary to the published policy of the Asphalt Institute and could have contributed to the distress that developed.

In effect, the Kelly test was no test at all. This was recognized by an official of the Corps of Engineers who, at a conference of the interested parties, later declared the asphaltic concrete surface placed on the demonstration test section at Kelly AFB was, in his opinion, still the best flexible airfield pavement for prototype traffic and a pavement just a little bit leaner would have carried 30,000 coverages of accelerated traffic without failure.

In all probability, the pavement built at Kelly, under any but the special and peculiar circumstances of the test, would have demonstrated a capacity to serve the requirements of our heaviest bombers without distress during the normal life-expectancy of the pavement.

One thing the aborted Kelly test did demonstrate: Base and subbase for flexible pavement can be built by normal contract procedures that will withstand accelerated traffic of these heavy wheel loads, and perform to the complete satisfaction of the most exacting engineer. In the confused accounts of the Kelly episode this is a fact that has been obscured.

NEW TEST CONDITIONS

Since the Kelly test, the Asphalt Institute has learned that new test loading conditions have been established which are not only totally without precedent but far exceed the limits of present engineering knowledge. The Corps of Engineers have embarked upon a program of testing pavements under 30,000 coverages of test loads of 325,000 pounds on twin tandem gear (81,250 pounds per tire) at tire pressures of 325 pounds per square inch, and at pavement temperatures not lower than 90 degrees F.

These wheel-assembly test loads are approximately three times those of the B–47 bomber. They are far in excess of landing-gear loads of any civil air transport, propeller or jet, existing or contemplated.

Designing any type of pavement to meet these test loads is an extrapolation into the unknown which can be established only through research. Knowledge must be gained through continued testing. Yet, testing by the Corps of Engineers has been suspended because no further funds have been allocated by the Air Force.

The Asphalt Institute believes this is a problem of vital concern to the national defense and the national economy. It feels that adequate research funds should be allocated from the defense budget if we earnestly hope to preserve properly engineered construction for our military establishment. With $43 billion of a proposed $72 billion national budget earmarked for the Department of Defense, the lion's share of which will be expended for air defense, it seems reasonable to expect a modest appropriation for continued airfield-pavement research.

The institute will, of course, continue its own research in this direction. Meanwhile, however, if there is any construction method which has proved it can meet these new test conditions, the institute wishes to propose this interim solution:

The pavement distress under these increased test loads occurs exclusively in a narrow track along the centerline of the runways and taxiways. Consequently, as an interim solution, it is suggested that the Corps of Engineers and the Air Force confine to the ends and center strips of its runways and taxiways whatever special construction may be required to handle this unprecedented channelized traffic. It is further suggested that the remainder of the runways and taxiways continue to be constructed of asphalt pavements because of their proven adequacy and economy.

This, we repeat, is offered as an interim construction policy in a period of accelerated transition, both in aircraft and pavement design.

It is pertinent to point out that 7 of our 10 busiest civilian airports are served by asphalt pavements. Nor does Commissioner James T. Pyle, of the Civil Aeronautics Administration, anticipate any need to make drastic changes in pavement design to accommodate tomorrow's jet transports. He has expressed the conviction that today's runway pavements, with some extensions where indicated, will be adequate for the transports now in design stage.

THE FALSE ANALOGY

The Asphalt Institute is seriously disturbed by the misleading interpretation being assigned to the abortive and unrealistic pavement test at Kelly AFB. The erroneous conclusions are being applied, frequently in all innocence, to highway construction.

Even if it were a valid test, which it was not, the Kelly AFB test could not yield data that would apply to highway paving needs. The extreme range of tire loads rules out even the remotest relationship. The maximum legal tire load permitted on our highways lies within the 5,000-pound–6,000-pound range. The Kelly test used a 50,000-pound tire load.

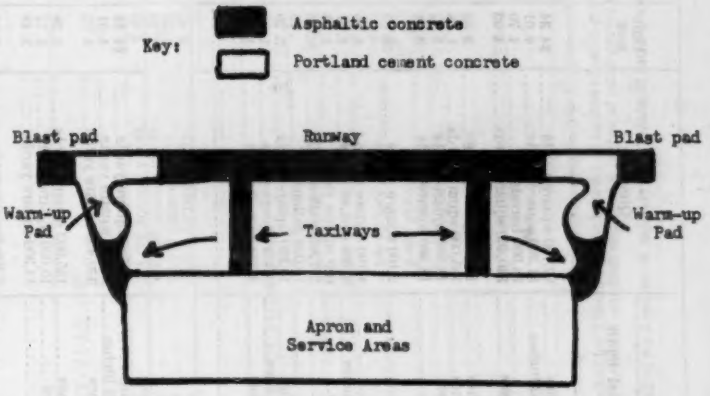
Further, highway truck tire pressures average 70 pounds per square inch; aircraft tire pressures used in the Kelly test were 200 pounds per square inch.

In the last 10 years the technology of asphalt paving has made tremendous strides. Whether a flexible pavement can be designed and built to meet the almost incredible test loadings recently introduced at Vicksburg (325,000 pounds at 325 pounds per square inch, etc.) is a question that only time and patient research can answer. Whether any construction can pass the test is an interesting matter for conjecture.

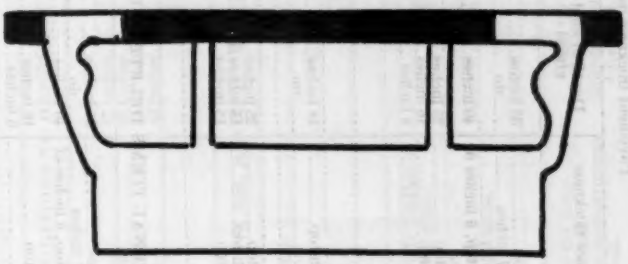
Meanwhile, thoughtful paving engineers will recognize the distinction between two very dissimilar pavement criteria (military bomber requirements versus civil airfield and highway needs) and will refuse to be led astray by a false analogy.

EXHIBIT E - 1

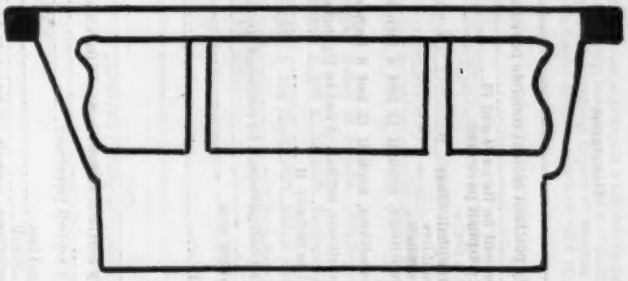
CHANGING PATTERN OF PAVEMENT DESIGN FOR MILITARY AIRFIELDS



1. Pavement structure at conclusion of 1954 Congressional hearing.



2. Design change approved in AF memo of June, 1955, establishing all primary taxiways as "critical areas."



3. Concrete specified for all "primary use pavement" in construction memorandum of May 28, 1956.

94407—57——16

EXHIBIT E–2

Dow Air Force Base, Bangor, Maine

ORIGINAL BID PRICES, OCT. 28, 1955

Item	Description	Pavement thickness design			Quantity	Unit cost	Total cost
		Surface thickness	Depth of sand-gravel	Total depth			
74	Heavy duty portland cement concrete pavement	15 inches	35 inches	50 inches	99,700 square yards	$4.34	$432,698.00
75	do	15 to 17 inches	do	50 to 52 inches	51,900 square yards	4.61	289,259.00
75a	Portland cement for items 74 and 75				98,000 barrels	4.70	460,600.00
76	Heavy duty asphalt pavement	4-inch top, 6 inches of stone.	40 inches	50 inches	340,400 square yards	4.02	1,368,408.00
77	Light duty asphalt fillets	3-inch top	25 inches	28 inches	1,000 square yards	3.64	3,640.00
78	Asphalt shoulders	2-inch top	16 inches	18 inches	155,000 square yards	1.28	198,400.00
79	Blast pad, asphalt	do	6 inches	8 inches	10,000 square yards	1.12	11,200.00
80	Overlay transitions, asphalt (2 feet 4 inches to 1½ inches).	do			14,300 square yards	3.48	49,764.00
81	Overlay transitions, asphalt (3 feet 6 inches to 1½ inches).	do			2,100 square yards	3.95	8,295.00
82	Overlay transitions, asphalt (6 feet to 1½ inches)	do			4,100 square yards	4.55	18,655.00
83	Odlin Rd	2½-inch top	18 inches	20½ inches	5,700 square yards	1.71	9,747.00
84	Access road to taxiway B	do	do	do	600 square yards	1.85	1,110.00
85	Prime coat				277,680 gallons	.16	44,428.80
86	Tack coat				76,020 gallons	.16	12,163.20
120	Light duty asphalt pavement for northeast approach lane	3-inch top	25 inches	28 inches	16,850 square yards	3.20	53,920.00
121	F St	2½-inch top	18 inches	20½ inches	2,330 square yards	1.85	4,310.50
122	Vehicle parking area	2-inch top	15 inches	17 inches	2,350 square yards	1.55	3,642.50
	Total						2,920,241.00

ORIGINAL ITEMS DELETED, JUNE 1956

74	Heavy duty portland cement concrete pavement	15 inches	35 inches	50 inches	99,700 square yards	$4.34	$432,698.00
75	do	15 to 17 inches	do	50 to 52 inches	51,900 square yards	4.61	239,259.00
76	Heavy duty asphalt pavement	4-inch top, 6 inches of stone.	40 inches	50 inches	340,400 square yards	4.02	1,368,408.00
78	Asphalt shoulders	2-inch top	16 inches	18 inches	155,000 square yards	1.28	198,400.00
79	Blast pad, asphalt	do	6 inches	8 inches	10,000 square yards	1.12	11,200.00
80	Overlay transitions, asphalt (2 fee 4 inches to 1½ inches).	do			14,300 square yards	3.48	49,764.00
81	Overlay transitions, asphalt (3 feet 6 inches to 1½ inches).	do			2,100 square yards	3.95	8,295.00

82	Overlay transitions, asphalt (6 feet to 1½ inches)	do			4,100 square yards	4.55	18,655.00
85	Prime coat				277,680 gallons	.16	44,428.80
86	Tack coat				76,020 gallons	.16	12,163.20
	Total						2,383,271.00

REVISION AND ADDITIONS TO ORIGINAL CONTRACT, JULY 1956

75a	Portland cement (increase over original)				230,000 barrels	$4.70	$1,081,000.00
135	Heavy duty portland cement pavement [1]	15 inches	47 inches	62 inches	314,700 square yards	6.49	2,042,403.00
136	do.[2]	17 inches	45 inches	do	109,000 square yards	7.10	773,900.00
137	do.[1]	15–17 inches	45–47 inches	do	32,100 square yards	7.50	240,750.00
138	do.[3]	19 inches	43 inches	do	36,300 square yards	8.47	307,461.00
	Total						4,445,514.00

DELETED ITEMS IN JUNE 1956, REVISED OR REPLACED IN OCTOBER 1956

80	Overlay transitions, asphalt (2 feet 4 inches to 1½ inches).[4]	2-inch top			14,300 square yards	$4.13	$59,059.00
81	Overlay transitions, asphalt (3 feet 6 inches to 1½ inches).[4]	do			2,100 square yards	4.77	10,017.00
82	Overlay transitions, asphalt (6 feet 0 inches to 1½ inches).[4]	do			4,100 square yards	5.72	23,452.00
85	Prime coat				100,000 gallons	.16	16,000.00
86	Tack coat				50,000 gallons	.16	8,000.00
139	Asphalt shoulders [5]	2-inch top, 6 inches of crushed stone.		18 inches	155,000 square yards	3.11	482,050.00
140	Double bituminous surface treatment of overrun area (850 by 300 feet).[6]				56,700 square yards	4.33	245,511.00
141	Blast pad, asphalt [7]	2-inch top, 6 inches of crushed stone.	6 inches	14 inches	10,000 square yards	4.73	47,300.00
	Total						891,389.00

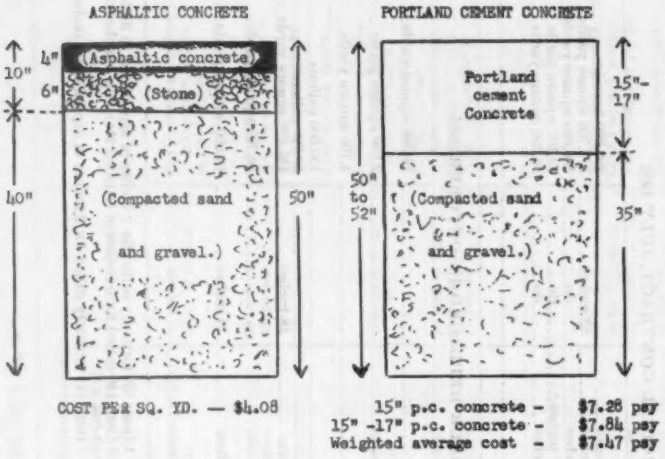
[1] Items 135 and 137 were formerly asphalt shown as item 76 in original bid items.
[2] Item 136 is the increase in design thickness of portland cement pavement.
[3] Item 138 is an increase in portland cement thickness on the final 500 feet ends of runway.
[4] Items 80, 81, and 82 require 6 inches of crushed stone under the asphalt.
[5] Item 139 formerly called for 2 inches of asphalt on 16 inches of sand-gravel.
[6] Item 140 called for 6 inches of crushed stone on 6 inches of sand-gravel on 37 inches of frost-free soil.
[7] Item 141 formerly called for 2 inches of asphalt on 6 inches of sand-gravel.

EXHIBIT E-2

DOW AIR FORCE BASE, BANGOR, MAINE

Pavement Thickness Design And Bid Cost

(Original Contract: October 29, 1955.)

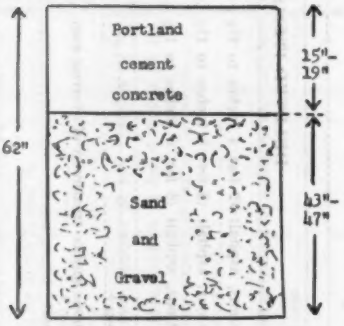


COST PER SQ. YD. — $4.08

15" p.c. concrete - $7.28 psy
15" -17" p.c. concrete - $7.84 psy
Weighted average cost - $7.47 psy

...BUT WHAT HAPPENED WHEN COMPETITION WAS ELIMINATED ? ?

Portland cement concrete pavement as contracted by negotiation in July, 1956



15" portland cement concrete - $9.42 p.s.y.
15"-17" portland cement concrete - $9.95 p.s.y.
17" portland cement concrete - $10.43 p.s.y.
19" portland cement concrete - $12.19 p.s.y.
Weighted ave cost, per sq. yd. $9.95.

Original total bid	$6,380,755.45
Original cost of paving items	2,920,241.00
Original cost of items deleted June 1956	2,383,271.00
Cost of items left in original contract	536,970.00
Cost of revisions and additions paving items	4,445,514.00
Cost of deleted items, replaced in October 1956	891,389.00
New cost of revised paving items	5,873,873.00
Original cost of pavement items	2,920,241.00
Net increase	2,953,632.00

Geiger Air Force Base, Spokane, Wash.

RECONSTRUCTION AND EXTENSION, RUNWAY 3–21, AND EXTENSION OF ALERT TAXIWAY

Contract: No. 45–108–57–101
Bids opened: February 21, 1957
Contract award: Schedule B
Design:
68,000 pounds on dual wheels
25,000 pounds light duty, alert taxiway

Asphaltic Concrete Runway, Taxiway, etc.:	*Inches*
Asphaltic concrete surface course	1½
Asphaltic concrete binder course	1½
Base, crushed gravel or rock, 1½ inches minus	6
Subbase, 2½ inches minus	4
Nonfrost material	20
Total	33

Portland Cement Concrete Runway:	
Portland cement concrete	11
Crushed gravel or rock	6
Nonfrost material	16
Total	33

Portland Cement Concrete Alert Taxiway:	
Portland cement concrete	10
Crushed gravel or rock	6
Nonfrost material	17
Total	33

EXHIBIT E–3

Bid tabulation

Item	Unit	Schedule A			Schedule B		
		Quantity	Unit cost	Total cost	Quantity	Unit cost	Total cost
Select material, fill, 4-inch minus	Cubic yard	83,300	$2.70	$224,910	95,500	$2.63	$251,165
Subbase, 2½-inch minus	do	15,000	4.20	63,000	70	20.00	1,400
Crushed gravel base, 1½-inch minus	do	15,400	5.00	77,000	29,300	3.85	112,805
Crushed stone base, 1½-inch minus	do	22,000	7.50	165,000	200	10.00	2,000
Compaction	Hour	500	25.00	12,500			
Portland cement	Barrel	30,300	4.00	121,200	95,400	4.85	462,690
Portland cement concrete	Cubic yard	20,200	20.00	404,000	63,600	12.10	769,560
Asphalt prime material	Ton	360	70.00	25,200	110	55.00	6,050
Asphalt tack material	do	130	75.00	9,750	1	100.00	100
Asphalt cement	do	1,630	60.50	98,615	186	49.00	9,114
Asphalt concrete	do	25,600	11.00	281,600	2,930	19.00	55,670
Paving items				1,482,775			1,670,554

Schedule A:

68,599 square yards portland cement concrete, per square yard	$9.97
158,746 square yards asphaltic concrete, per square yard	5.75
Cost difference, per square yard	4.22

Schedule B:

215,986 square yards portland cement concrete, per square yard	7.55
18,169 square yards asphaltic concrete, per square yard	6.09
Cost difference, per square yard	1.46

Total bids:

Schedule B, Gibbons & Reed Co	2,518,315.50
Schedule A, Morrison-Knudsen Co., Inc	2,348,991.60
7.2 percent savings (if awarded schedule A)	169,323.90

EXHIBIT E-3

GEIGER AIR FORCE BASE, SPOKANE, WASHINGTON

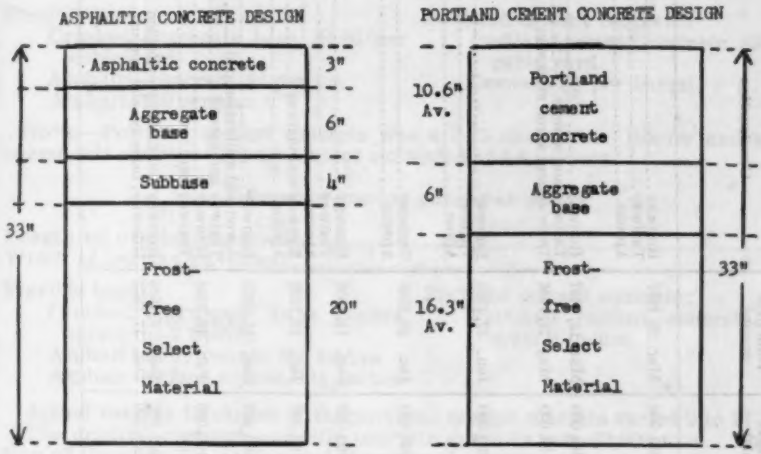
Contract #45-108-57-101: Alternate Schedules

(Bids opened 21 February 1957)

SCHEDULE "A" (25,000 tons asphalt; 20,200 cubic yards concrete).....$2,348,991.60

SCHEDULE "B" (2,930 tons asphalt; 63,600 cubic yards concrete)..... 2,518,315.50

Contract awarded Schedule "B" at an additional cost of.....$ 169,323.90



NOTE: When paving items only are compared, an additional savings of $18,455.10 might have been realized from Schedule "A". The total difference on this basis was $187.779.00

EXHIBIT E-4

COMPARISON OF ACTUAL PAVEMENT COSTS AT EXISTING INSTALLATIONS

The following items are cost comparisons of asphaltic concrete and portland cement concrete pavement with underlying parts of construction at various airfields.

These items were taken from bid tabulations at the Office, Chief of Engineers, United States Army, Gravelly Point, Va., or were supplied by district engineers of the Asphalt Institute.

Airfield	Design load (pounds)	Date bids opened	Construction	Asphaltic concrete		Portland cement concrete	
				Square yards	Cost per square yards	Square yards	Cost per square yard
Minot Air Force Base, Minot, N. Dak.	100,000-240,000	Mar. 28, 1957	Runway	158,888	$10.11	146,111	$14.02
			Taxiway	1,625	10.11	34,166	13.92
			Aprons			220,359	13.14
Asphaltic concrete cost $3.37 per square yard less than portland cement concrete.							
Grand Forks Air Force Base, N. Dak.	100,000-240,000	Mar. 13, 1957	Runway			286,066	11.25
			Taxiway and aprons			417,030	11.48
Portland International Airport (Air National Guard facilities), Portland, Oreg.	25,000	May 21, 1956	Taxiway and apron extension	20,700	4.51	12,835	8.68
Asphaltic concrete cost $4.17 per square yard less than portland cement concrete.							
Davis-Monthan Air Force Base, Calif.	100,000	Jan. 27, 1956	Runway	26,940	3.74	28,888	6.64
			Taxiway	21,366	3.47	199,278	6.05
			Apron			13,758	6.13
Asphaltic concrete cost $2.51 per square yard less than portland cement concrete.							
Minot Air Force Base, N. Dak.	100,000-240,000	Jan. 20, 1955	Taxiway	7,816	7.45	10,030	11.02
			Aprons			50,745	14.89
Asphaltic concrete cost $6.80 per square yard less than portland cement concrete.							
Fairchild Air Force Base, Calif.	100,000	Jan. 14, 1955	Runway	200,764	2.60	34,267	7.20
			Taxiway	53,223	2.59	14,400	7.19
			Aprons	5,089	2.60	236,671	7.19
Asphaltic concrete cost $4.59 per square yard less than portland cement concrete.							
Turner Air Force Base, Albany, Ga.	100,000	Jan. 13, 1955	Runway and taxiway	236,190	3.36	209,700	5.39
			Aprons			14,350	5.48
Asphaltic concrete cost $2.04 per square yard less than portland cement concrete.							
Plattsburgh Air Force Base, Plattsburgh, N. Y.	100,000	Jan. 11, 1955	Runway			32,150	6.23
			Apron and calibration pad			276,287	6.25
			Taxiway and aprons			127,850	6.27
Kirtland Air Force Base, Albuquerque, N. Mex.	100,000	Feb. 16, 1954	Runway	256,232	2.38	33,333	7.02
			Taxiway, etc.	245,200	2.38	46,067	7.02
Asphaltic concrete cost $4.64 per square yard less than portland cement concrete.							
George Air Force Base, Victorville, Calif.	100,000	Dec. 1, 1953	Runway and taxiway extension	73,527	1.54		
Pinecastle Air Force Base, Orlando, Fla.	100,000	Dec. 17, 1952	Runway, taxiway, and aprons	253,670	3.03	286,480	6.65
Asphaltic concrete cost $3.62 per square yard less than portland cement concrete.							

(From Charles A. McKeogh, district engineer, the Asphalt Institute, New Orleans, La., April 26, 1957)

ALEXANDRIA AIR FORCE BASE, ALEXANDRIA, LA.

Runway, portland cement concrete; taxiway, portland cement concrete; apron, portland cement concrete.

Contract awarded to T. L. James Co., May 1955, for the construction of hot-mix asphaltic concrete taxiways, hot-mix asphaltic concrete overlay on runway with 1,000 feet portland cement concrete ends, hot-mix asphaltic concrete shoulders and blast pads.

The following contract modifications were initiated in the order listed:

1. Asphaltic concrete shoulder paving deleted.
2. Asphaltic concrete taxiway changed to portland cement concrete.
3. Runway asphaltic concrete overlay changed to portland cement concrete.
4. Blast pads, width changed from 50 feet to 25 feet.

ORIGINAL CONTRACT UNIT PRICES

Flexible base:
Crushed aggregate base, $4.96 per cubic yard.
Asphaltic concrete, $6 per ton.
Asphalt, $20 per ton.

Portland cement concrete:
Portland cement concrete, $9.97 per cubic yard.
Cement, $4 per barrel.

NOTE.—Portland cement concrete was a 5.75 sack mix. Binder and surface course mix average asphalt content estimated at 4.6 percent.

Runway overlay pavement design

	Feet
Length of overlay pavement	6,000
Width of overlay pavement	150

Flexible base:
Crushed aggregate base course, minimum 7 inches.
Asphalt binder course, 2½ inches.
Asphalt surface course, 1½ inches.

Portland cement concrete:
Portland cement concrete, minimum 9 inches.

Actual overlay thickness of the portland cement concrete varied 9 to 17 inches.

The original contract asphaltic concrete quantity was 63,000 tons. The deletion of the shoulder paving and changing the taxiways to portland cement concrete reduced the tonnage to approximately 32,000 tons. An adjustment of the asphaltic concrete price for ramps, blast pads, and runway overlay was as follows:

Asphaltic concrete (ton)	$6.32
Asphalt (no change)	20.00
Concrete aggregate base course (cubic yards)	5.21

The runway overlay was changed to portland cement concrete which resulted in an adjustment of the portland cement concrete prices as follows:

Portland cement concrete (cubic yards)	$11.20
Cement (barrel—no change)	4.00

The portland cement concrete overlay thickness varied 9 to 17 inches. It required approximately 36,000 cubic yards to complete the overlay. The contractor furnished this 36,000 cubic yard figure.

The 36,000 cubic yards of portland cement concrete used to complete the overlay of the 6,000 feet by 150 feet runway section indicates an average thickness of 13 inches. This average thickness was used to calculate an estimated cost of the flexible overlay for comparison with the portland cement concrete overlay cost.

Flexible base

4 inch asphaltic concrete	$155,680
9 inch crushed aggregate base course	130,250
Total cost	285,930

Portland cement concrete

Portland cement concrete	$403,200
Portland cement	207,000
Total cost	610,200
Portland cement concrete	610,200
Flexible	285,930
Asphalt less costly by	324,270

NOTE.—Verbal reports estimated that the portland cement concrete overlay cost was an additional $300,000 or as stated "around $300,000."

NOTE.—All information was obtained from an employee of the contractor by telephone. All calculations were made by the writer (C. A. McKeogh) based on the information obtained.

The explanation given for changing the flexible overlay to a portland cement concrete overlay was that a crushed gravel was to be used for the base course. The job specifications permitted the use of crushed gravel, and the contractor bid the job to use crushed gravel.

Crushed limestone, for base course, was available from Fort Smith and Big Rock, Ark., and a survey would probably show other economical sources.

There was no objection to the use of crushed gravel for the asphaltic concrete pavement.

LITTLE ROCK AIR FORCE BASE, LITTLE ROCK, ARK.

Runway: Hot mix asphaltic concrete, 1,000 feet portland cement concrete ends.
Taxiways: Hot mix asphaltic concrete.
Apron: Portland cement concrete.

FIRST CONTRACT, AUGUST 1955

Contract awarded to Tecon, Dallas, Tex.
Runway: 8,100 feet by 200 feet; 6,100 feet hot mix asphaltic concrete, 1,000 feet portland cement concrete ends.
Taxiways: Hot-mix asphaltic concrete.
Apron: Portland cement concrete.

DESIGN

Flexible:
4 inch asphaltic concrete
6 inch crushed aggregate base course
14 inch select material subbase
Rigid:
15 inch portland cement concrete
17 inch portland cement concrete

Item	Quantity	Unit price
15-inch portland cement concrete pavement	257,000 cubic yards	$7.33
Portland cement	353,400 barrels	3.88
Prime coat	103,900 gallons	.15
Tack coat	41,100 gallons	.15
Crushed aggregate base	37,400 cubic yards	4.00
Select subbase	102,000 cubic yards	2.75
Asphaltic concrete	52,000 tons	5.10
Asphalt	642,000 gallons	.11

SECOND CONTRACT, SEPTEMBER 1955

Contract awarded to Farnsworth & Chambers.
Taxiway: Asphaltic concrete.
Calibration hardstand: Portland-cement concrete.

Item	Quantity	Unit price
15-inch portland cement concrete pavement ..... cubic yard	111,000	$7.21
Portland cement ..... barrel	160,000	3.88
Prime coat ..... gallon	10,000	.18
Tack coat ..... do	500	.25
Crushed aggregate base ..... cubic yard	6,400	4.15
Select subbase ..... do	1,300	3.50
Asphaltic concrete ..... ton	4,000	6.15
Asphalt ..... gallon	55,000	.11

THIRD CONTRACT, OCTOBER 1955

Contract awarded to Farnsworth & Chambers.
Apron: Portland-cement concrete.
No alternate bid.

Item	Quantity	Unit price
15-inch portland cement concrete pavement ..... cubic yard	151,700	$6.34
Portland cement ..... barrels	208,600	3.88

FOURTH CONTRACT, FEBRUARY 1957

Contract awarded to Ben Hogan Co.
Runway extension: Portland-cement concrete.
Taxiway: Portland-cement concrete.
No alternate bid.

Item	Quantity	Unit price
15 inches to 17 inches portland cement concrete pavement	36,000 cubic yards	$7.96
Portland cement	51,500 barrels	4.00

KELLY AIR FORCE BASE, SAN ANTONIO, TEX.

Contractor: H. B. Zachry Co., July 1955–October 1956.

DESIGN THICKNESS

Flexible pavement:
- 18-inch select subbase CBR— 15 plus.
- 12-inch select subbase CBR—40 plus.
- 6-inch crushed aggregate case CBR—80 plus.
- 4-inch asphaltic concrete.

Rigid pavement:
- 6-inch select subbase.
- 18-inch portland cement concrete.
- 20-inch portland cement concrete.

Price per square yard

Item	Square yards	Price, square yard
40 inch flexible pavement (runway)	327,822	$3.00
18 inch–20 inch portland cement concrete (runway)	68,000	5.14
18 inch portland cement (apron)	188,850	5.14
11 inch portland cement (overlay)	31,418	2.98
18 inch portland cement (apron)	100,000	(?) 5.50
18 inch–20 inch portland cement concrete (taxiway)	----------	(?) 5.50

NOTE.—Information on the last two items above (those with question marks) is not firm. File not immediately available to the party that obtained the information for the writer. This will be difficult to obtain accurately as there was a large contract modification when the asphaltic concrete taxiway was changed to portland cement concrete.

LAREDO AIR FORCE BASE, LAREDO, TEX.

Contractor: Cage Bros. (October 1953 to June 1954).
Parallel runway and taxiways.
Flexible base design:
8½ inch, 7½ inch select subbase.
6 inch crushed aggregate base.
3½ inch asphaltic concrete.

Price per square yard

Item	Square yard	Price per square yard
Flexible base runway	125,000	$2.62
Flexible base taxiway	71,067	2.92

Contractor: Cage Bros. (January 1952–June 1952; runway extension and taxiway.
Alternate bids.

THICKNESS DESIGN

Flexible base:
10-inch, 11-inch crushed aggregate base.
3-inch asphaltic concrete.
Rigid: 6-inch, 7-inch portland cement concrete.

Item	Square yard	Price square yard
Flexible base runway	31,661	$2.04
Flexible base taxiway	33,742	2.01
Portland cement concrete, 6 inches	(1)	2.37
Portland cement concrete, 7 inches	(1)	2.62

[1] Alternate bid.

LAUGHLIN AIR FORCE BASE, DEL RIO, TEX.

Contractor: Cage Bros. (February–September 1922).
Runway extension and taxiway—alternate bids.

THICKNESS DESIGN

Flexible base:
6-inch crushed aggregate base.
3-inch asphaltic concrete.
Rigid: 6-inch portland cement concrete.

Item	Quantity	Price per square yard
Flexible base runway	17,400 square yards	$2.23
Flexible base taxiway	28,100 square yards	2.20
6-inch portland cement concrete runway	Alternate bid	3.34
6-inch portland cement concrete taxiway	do	3.34
Runway extension and taxiway, design same as above: flexible base	79,920 square yards	2.17

Contractor: H. B. Zachry Co. (April 1953 to March 1954).
Parallel runway and taxiways.

THICKNESS DESIGN

Flexible base:
11-inch crushed aggregate base.
3-inch asphaltic concrete.

Item	Square yards	Price per square yard
Flexible base runway	127,500	$1.71
Flexible base taxiway	17,200	1.71

Tabulated below are the square yards of rigid pavement placed and price per square yard during the period 1955 to present. No flexible base bids were requested.

Item	Thickness (inches)	Square yards	Price per square yard
Apron	6	89,758	$2.62
Do	6	49,632	3.44
Do	11	1,100	5.06
Do	7	6,498	3.21
Do	10	3,250	6.50

LAKE CHARLES AIR FORCE BASE, LA.

Contractor: T. L. James Co. and W. R. Aldrich, awarded March 1955.
All airfield pavement portland cement concrete.
Asphaltic concrete shoulders.
Tabulated below are the square yards of portland cement concrete airfield pavement with the price per square yard:

Award date	Thickness (inches)	Square yards	Price per square yard
June 1951	13	198,670	$5.98
Do	16	188,890	7.30
Do	17	548,880	7.75
January 1953	16	13,083	8.95
Do	17	58,033	9.61
March 1954	17	125,000	8.22
November 1953	13	33,969	6.82
April 1954	17	22,692	9.98
September 1954	17	9,698	11.31
November 1954	17	287,000	8.84
Do	17	30,484	8.36
March 1955	17	10,209	9.68
Do	17	32,682	9.56

Thickness design of flexible base shoulders and blast pad:
6-inch select subbase.
6-inch crushed aggregate base.
3-inch asphaltic concrete.

Item	Square yards	Price per square yard
Shoulders	80,178	$4.09
Blast pad	9,600	4.19

EXHIBIT E–5. SUPPLEMENTAL MATERIAL

THE ASPHALT INSTITUTE,
Kansas City, Kans., May 24, 1957.

Subject: Richards-Gabaur Airbase, Grandview, Mo.

Mr. ARVIN S. WELLBORN,
Chief Engineer, The Asphalt Institute,
University of Maryland, College Park, Md.

DEAR MR. WELLBORN: In accordance with our telephone conversation yesterday, we have obtained the following information, as requested, pertaining to the original plans for overlay of runways on the Richards-Gabaur Air Base at Grandview, Mo.; and following this development the withdrawal of plans for overlay and orders received for local consultant firm, Burns & McDonnell, to develop plans for immediate letting of complete portland cement concrete runway.

Originally the plans were to repair completely all existing cracked and broken areas on a 5,500-foot section of the existing north-south runway with asphalt and then overlay the entire surface with 2-inch asphaltic concrete. In discussing this with Elmer Miller, with Burns & McDonnell, we indicated this was not an adequate amount of asphalt overlay and he too agreed with that. However, his instructions were to carry on since this plan was being used as a temporary expedient to protect the jet fighter planes using the field from particles of concrete which were scaling off and damaging the motors; and it was contemplated that some time within the next few years a major construction program would be executed.

1. On April 23 plans and specifications for the original 2-inch overlay were released for bid with the letting scheduled for May 10, 1957.

2. On May 8, 1957, the letting date was postponed until May 15, 1957.

3. On May 13, 1957, proposals for resurfacing were withdrawn and instructions were received from USAF Headquarters in Washington to initiate a major construction program.

4. After consultation between the consultant and Air Force engineers, the consultant was instructed to design a portland cement slab with request that plans be rushed for a notice of letting on May 29 with a scheduled bid opening on June 20, 1957.

Design is to be for 25,000-pound single-wheel load and 200 per square inch tire pressure. Present design is for 11 inches of portland cement concrete with 4 inches of crushed stone base.

This airbase is now serving jet fighters and conventional aircraft of all kinds and intended future use is for Jet 102 fighters as well as all kinds of conventional aircraft.

Very truly yours,

M. R. ROYER, *District Engineer.*

EXHIBIT E–6.—SUPPLEMENTAL MATERIAL

ESSO STANDARD OIL CO.,
New York, N. Y., June 4, 1957.

Mr. ARVIN WELLBORN,
The Asphalt Institute, Asphalt Institute Building,
University of Maryland, College Park, Md.

DEAR MR. WELLBORN: During the past week, I had an opportunity to visit the subject Air Force installation to view the concrete ramp which was completed in 1956 by the Lane Construction Corp. This ramp, approximately 18 acres in extent, consists of a 14-inch concrete pavement placed on a 40-inch granular base.

The ramp appeared to be well constructed and the cross section of the concrete, as viewed at a test hole, appeared to be dense and with no segregation of aggregate in the concrete mixture. The aforementioned test pit was cut through the concrete in an area where a long crack had appeared in the concrete in March of this year and which has now opened up to approximately one-eighth of an inch at the surface. The crack goes through the entire slab. I was informed that the crack had started as a very fine hair crack and has become progressively larger. I walked over much of the ramp area and spotted several similar cracks throughout the ramp which have all been dated as to the time they first appeared by field personnel. A few early cracks, apparently caused by poor drainage, have widened sufficiently to require their being filled with crack sealer.

In spite of the fact that the workmanship appears to be excellent, the progressive appearance of cracks is causing great concern to the Air Force and I have information from an authoritative source that the Air Force is considering the condemnation of the entire apron, which has had no traffic, the removal of the slab, and a buildup of the granular base to 56 inches prior to the placement of another pavement. A decision on this matter is expected in the near future.

I was informed that the concrete paving of the new runway, under construction by J. R. Cianchette, has been stopped pending a decision by the Air Force as to their future course of action with respect to all concrete paving. I am informed that cracks are also appearing on the concrete taxiway and on the runway although I had no opportunity to observe either of these installations personally. I was informed, however, that the concrete taxiway, also built by J. R. Cianchette, was somewhat rougher than the apron paving placed by Lane.

In connection with the Cianchette contract, it is my understanding that the contractor is being paid $8,000 per week for rental for idle equipment used on the job. I do not know when this rental arrangement became effective but assume that it would apply since the date when the contractor might have been able to commence work this spring and will extend until a decision is reached on the paving so that the contractor can go back to work.

I will keep in close touch with this situation and expect to have some indication of the decision relative to removal of the concrete slabs now in place and the "beefing up" of the granular base.

Very truly yours,

W. D. CRAIG.
By A. R. CURTIS.

Mr. HÉBERT. All right, Mr. Wellborn.

Mr. WELLBORN. The material in our exhibits falls into five categories.

Exhibit A is a chronological record of events since the suspension of the 1954 congressional hearing on this subject. I believe it provides a coherent background for this hearing. Beyond that, it offers an interesting study in tactics, with the Air Force apparently maneuvering persistently toward total elimination of asphalt paving from all airfield pavement areas on its installations.

Neither will I dwell for long on exhibit B which simply documents the recognized and unchallenged economy of asphalt construction. This simple engineering fact is unquestioned in highway building and we find here supporting statements by both military and civilian airfield experts pointing up the fact that this construction cost differential between asphalt and concrete is carried over into airfield construction.

Exhibit B–2 shows cost differences offered by Mr. Earle C. Peck, supervising civil engineer, Headquarters, Technical Training Air Force, United States Air Force.

Exhibit B–3 indicates the tremendous savings realized by the city of Chicago in the construction of a new runway at O'Hara Field.

Exhibit B–4 includes an excerpt of an official memorandum from Brig. Gen. David H. Tulley, then Assistant Chief of Engineers for Construction, United States Army, to Chief of Staff, United States Air Force. I believe part of this memorandum is worth repeating here:

A summary of the tabulation also furnished your headquarters, discloses that on a nationwide average, the rigid-type pavement (portland cement concrete) costs 83 percent more for heavy-duty pavements and 90 percent more for light-duty pavements than for the equivalent pavements in the flexible type (bituminous).

Although the tabulation to which Brigadier General Tulley refers was made in 1952 and 1953, there is no reason to expect the cost

differential between the two pavement types to be any less today on a competitive basis.

Exhibit C documents the Asphalt Institute's contention that heavy-duty asphalt pavements are now carrying the heaviest aircraft traffic—and doing a superb job. This is confirmed by Air Force engineers themselves. Exhibit C–3 contains a statement attributed to Gen. Curtis LeMay to the effect that only two United States airfields—at Merced, Calif., and at Limestone, Maine—are properly equipped to handle the huge intercontinental bombers. This exhibit includes pictures of these two airfields. Please note that they are largely constructed with asphalt. Exhibit C–4 contains a statement by Mr. Paul T. Sutton, pavements engineer, Air Proving Ground Command, Eglin Air Force Base, Fla.

I would like to call your special attention to this statement as it is an excellent analysis by an Air Force engineer of the Air Force criteria eliminating asphalt.

Exhibit C–6 contains an exhaustive survey, by institute field engineers, of certain continental air bases designated as SAC installations, as well as others. The inspection reports indicate that these asphalt-paved runways and taxiways, used extensively by our heaviest jet bombers, are performing generally to the satisfaction of the base and plane commanders, and certainly to the satisfaction of the taxpayers if we can judge by the paving economy disclosed in these reports. I would like to emphasize that the few isolated instances of asphalt-pavement distress are exceptions to the general pattern—and, in every case, can be explained by faulty design, construction, or maintenance procedures.

The Air Force has attempted to discredit heavy-duty asphalt airfield pavements by citing several cases of distress in taxiways subjected to B–47 channelized traffic. In not a single case cited had the asphalt pavement been designed for channelized traffic. At the time these pavements were built, the effects of channelized traffic were not known. Exhibit D offers a somewhat more analytical study of these alleged pavement failures.

Exhibit D also contains an engineering analysis of the so-called Kelly test, on which the Air Force leans heavily when passing critical judgment on asphalt pavements. The exhibit is self-explanatory, but I would like to go one step further and point out that if one were deliberately setting out to discredit asphalt pavement, he could set up no better situation than the Kelly test. These are the conditions imposed in this unrealistic test:

1. The Air Force required the asphalt pavement to be designed on the basis of criteria established with 1,500 coverages of accelerated test traffic at high pavement temperature.

2. Test traffic required at Kelly, however, was 30,000 coverages, that is at high temperature, or 20 times the amount on which the pavement mix design criteria were based. Therefore, for these conditions, the asphalt mixture was clearly too rich.

Missing the asphalt content is certainly not an indictment on the Corps of Engineers. Remember, they were testing to learn what should be the proper asphalt content under these loading conditions.

Our point is that the Air Force should have permitted a correction and retest.

3. All test traffic was applied at Kelly under high pavement temperature conditions, a situation not encountered in actual airfield pavements. As any technologist knows, this is abnormally severe for asphalt pavement and not similarly severe for rigid pavement. The severe test on rigid pavement would be loadings in extreme cold nighttime conditions.

4. Spacing of test traffic load wheels was 20 feet instead of approximately 40 feet, as for the B–47 aircraft. This factor may have eliminated for all practical purposes rebound and recovery factors and induced interfacial stresses of a high order of magnitude.

5. So-called "antistrip" additive was placed in the hot asphalt mixture. This procedure is contrary to the published policy of the Asphalt Institute and could have contributed to the distress that developed.

In effect, the Kelly test was no test at all. This was recognized by an official of the Corps of Engineers who, at a conference of the interested parties, later declared the asphaltic concrete surface placed on the demonstration test section at Kelly AFB was, in his opinion, still the best flexible airfield pavement for prototype traffic and a pavement just a little bit leaner would have carried 300,000 coverages of accelerated traffic without failure. In fact, within a few weeks after the Kelly test was stopped, it was proven at Vicksburg Waterways Experiment Station that asphalt pavement could be built to withstand the unrealistic conditions imposed at the Kelly test.

In all probability the pavement built at Kelly, under any but the special and peculiar circumstances of the test, would have demonstrated a capacity to serve the requirements of our heaviest bombers without distress during the normal life expectancy of the pavement.

I think it's noteworthy, in passing, to refer to the fact that the failed asphalt surfacing on the test section at Kelly was removed with a blade grader after the test and replaced with a standard-construction heavy-duty hot-mix-asphalt surfacing. We were led to understand that this taxiway has now been in constant service for 9 months, carrying channelized bomber traffic, and is performing excellently—just as all asphalt pavements will do when properly designed and constructed.

We have established the undisputed economy of asphalt paving in exhibit B and demonstrated in exhibit C its ability to serve our heaviest bomber traffic. In exhibit D we have explained why the Kelly test was not a true test of the performance of asphalt pavement under channelized bomber traffic. I will close now with a few appropriate observations on the material cataloged under exhibit E.

By June 1956, the Air Force had accomplished its pavement mission. Without any formal change in paving policy, the Air Force had relegated asphalt paving to training fields, runway overruns and shoulders—and here only on an if, as, and when basis, subject to review. Asphalt had been ruled off of those areas not subjected to channelized traffic where it could, without question, serve adequately. All work up for bids at this point was flagged down and the asphalt alternates killed. Where actual bids had been received, new bids were asked specifying concrete paving only, and contracts already awarded were renegotiated.

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A case in point was the Dow Air Force Base near Bangor, Maine. Here we have the story in a nutshell. These are alternate designs. May I have the chart up there, please.

These are alternate pavement designs, one asphaltic concrete and the other portland-cement concrete. When bids were first taken in October 1955 both types of pavement were to be used on the field, depending upon the critical nature of the area to be paved and on the cost differential where asphalt was acceptable. The asphaltic concrete bid was $4.08 per square yard. Various thicknesses of portland-cement-concrete pavement were bid at prices ranging from $7.28 to $7.84 per square yard.

But the new criteria memorandum of May 28, 1956, washed these figures off the board. In July 1956 the contract for Dow Air Force Base was renegotiated on an all-concrete design, as you see on the chart on the blackboard.

Here's the result: 15-inch portland-cement-concrete pavement that was bid in at $7.28 per square yard in competition with asphalt pavement was raised to $9.42 per square yard—an increase of $2.14 per square yard with only the addition of 12 more inches of sand-gravel subbase. In the absence of competition, the cost of concrete paving jumped 29 percent. The total cost of paving items for this project soared from $2,920,241 to $5,843,843.

Now let's consider a different type of situation. Geiger Air Force Base at Spokane, Wash., is not a heavy-bomber base. The design does not call for a heavy-duty pavement and there's no earthly reason for barring asphalt pavement. Although alternate bids were taken, the Geiger contract was awarded to the higher bidder for all-concrete construction.

Gentlemen, exhibit E and its supplements also offer several other examples of this type of disregard for economy and fair competition in airfield paving. I commend them to your earnest consideration. Thank you.

Mr. HÉBERT. Does that complete your statement?

Mr. WELLBORN. Yes, sir.

Mr. HÉBERT. Mr. Wellborn, in your statement you indicated an officer or official of the Corps of Engineers. You did not identify the individual. Who was it?

Mr. GAVIN. On page 4.

Mr. WELLBORN. This official was Mr. Turnbull, Mr. Hébert.

Mr. HÉBERT. That is the gentleman who has been here?

Mr. WELLBORN. Is present today, I believe.

Mr. HÉBERT. Correct.

Now in connection with the Dow Air Force Base, I understand you to say that it was noncompetitive and arbitrarily given to concrete, which caused the immediate rise in the price, of some $2 million?

Mr. WELLBORN. Yes, sir. It was first let to the original criteria established by this committee.

Mr. HÉBERT. In other words, bids were received on the original criteria?

Mr. WELLBORN. Yes, sir; and the contract awarded.

Mr. HÉBERT. The contract awarded to flexible, or asphalt?

Mr. WELLBORN. A combination of flexible and rigid.

Mr. HÉBERT. Then it was canceled and then awarded to the concrete—or the rigid?

Mr. GAVIN. No.

Mr. HÉBERT. That is what he said.

Mr. WELLBORN. It was renegotiated.

Mr. GAVIN. There were new criteria submitted in the new bid, wasn't there, from 1955 to 1956? It says, "New criteria memorandum of May 28, 1956, washed these figures off the board."

Mr. HÉBERT. That is correct.

Mr. WELLBORN. And the contract was renegotiated.

Mr. HÉBERT. Renegotiated.

Mr. GAVIN. That is right.

Mr. HÉBERT. Renegotiated up?

Mr. GAVIN. What was the new criteria memorandum for the one that was asked for in the bid taken in October of 1955?

Mr. WELLBORN. It is the criteria which is in question at this meeting, I believe, Mr. Gavin.

Mr. GAVIN. Was the criteria different in 1956 than it was in 1955?

Mr. WELLBORN. Yes, sir.

Mr. GAVIN. Well, would that make a difference in the bidding, if the criteria was changed—in the price?

Mr. WELLBORN. Well, the contract was renegotiated, Mr. Gavin. It didn't have any bids on the second contract.

Mr. HÉBERT. Renegotiated up, of over $2 million; is that correct?

Mr. WELLBORN. Yes, sir.

Mr. HÉBERT. That is correct?

Mr. WELLBORN. Yes, sir; to the best of my knowledge, it is correct.

Mr. HÉBERT. Now in connection with the observation that you made, Mr. Wellborn, on the Kelly tests, Mr. Courtney, will you notify the Air Force that we expect them to have competent witnesses to answer in detail each one of these allegations made by Mr. Wellborn?

Mr. COURTNEY. Yes, Mr. Chairman.

Mr. RIVERS. Mr. Chairman, at that point, under what authority of law can they change a competitive bid and substitute a negotiated bid? I think they do it under the theory of something critical during the course of construction.

Mr. COURTNEY. No; it gets back to the proposition that the subcommittee considered, Mr. Chairman.

Mr. HÉBERT. Negotiation against competitive bidding.

Mr. COURTNEY. Under the emergency powers of the Korean national emergency.

Mr. RIVERS. You see, because 95 percent of all construction is competitive.

Mr. COURTNEY. Yes.

Mr. RIVERS. And 95 percent of the spending is negotiated.

Mr. COURTNEY. That is right.

Mr. RIVERS. The overall spending.

Mr. COURTNEY. That is right.

Mr. RIVERS. But in the construction phase of the military, it has been boastfully said that all of our stuff is competitive.

Mr. COURTNEY. Nevertheless, that is voluntary compliance, if you please, with the advertised competitive-bidding procedure.

Mr. RIVERS. I think we write it in the public-works law. I believe we covered it in all the public-works statutes.

Mr. COURTNEY. You still haven't taken away the Korean national emergency.

Mr. RIVERS. So that would come under that emergency.

Mr. COURTNEY. It could.

Mr. RIVERS. So all that would have to be done, Mr. Courtney—I wish you would check this—would be for somebody to certificate the emergency feature of a project, and all negotiations can be obviated or discarded. Is that what I understand?

Mr. COURTNEY. That is my understanding.

Mr. RIVERS. Is that your understanding?

Mr. COURTNEY. That is my understanding.

Mr. RIVERS. I wish you would check it.

Mr. COURTNEY. I will check it.

Mr. HÉBERT. That is the reason we want the competent witnesses of the Air Force to answer in detail each one of these allegations made by Mr. Wellborn.

Mr. MILLER. Mr. Wellborn, you speak of changing the criteria now. Do I understand that there was a change in the criteria for permanent-type pavement, during the time it was bid in connection with the flexible type as against the time it was negotiated, or did they negotiate on the same basis for permanent pavement that originally took place in the first instance?

Mr. WELLBORN. Mr. Miller, first let me say I don't understand the term, permanent pavement. I don't believe there is such a thing.

Mr. MILLER. All right, let's say concrete pavement and asphalt pavement. I recall the other day I had to say permanent and flexible.

Mr. WELLBORN. Of course, I am not familiar——

Mr. RIVERS. Rigid and flexible.

Mr. WELLBORN. Yes. Of course, I am not familiar with the details of renegotiation. I am only familiar with the dates in which the original bids and contract were awarded.

Mr. MILLER. Was there any change in the specifications, for rigid pavement?

Mr. WELLBORN. There was a slight change—there was a change as I said in my statement, where they added, I believe, as I recall, 10 inches more of subbase under the concrete pavement on the renegotiated contract.

Mr. HESS. Mr. Wellborn, let's get the story of this Geiger Air Force Base at Spokane, Wash. When was that contract let?

Mr. WELLBORN. The contract was let, as I recall, about 4 months ago. I don't have the date.

Mr. HESS. That was after the new criteria?

Mr. WELLBORN. I understand February of 1957.

Mr. HESS. Then it was after the May 28, 1956, new criteria?

Mr. WELLBORN. Yes, sir. However, they did still take alternate bids.

Mr. HESS. Yes; I noted that you said that, that they asked for alternate bids. Well, can you give any reason at all why they should ask for alternate bids after the new criteria was put in effect?

They asked you to go to the trouble, or asked the contractor to go to the trouble, to give alternate bids on something that they knew they were not going to build.

Mr. WELLBORN. That is a mystery to us, Mr. Hess. This is a light-duty field, too. This is not a heavy-duty field.

Mr. HESS. I say, that seems to be the story here, doesn't it?

Mr. WELLBORN. Yes, sir.

Mr. HESS. Asking for bids on something that they knew, that their own criteria which they laid down, would not permit them to do.

Mr. WELLBORN. I don't know what their intentions were, but the results were quite——

Mr. HESS. They took the high bidder?

Mr. WELLBORN. Yes, sir.

Mr. HESS. Was it the high bidder on rigid?

Mr. WELLBORN. Yes, sir.

Mr. HESS. The high bidder of all bidders on rigid.

Mr. COURTNEY. No. The high bidder was rigid.

Mr. HESS. The high bidder was rigid.

Mr. BUCHANAN. As between the two.

Mr. HESS. I see.

Do you happen to know the differential there between——

Mr. WELLBORN. $169,000, I believe.

Mr. HESS. All right.

Mr. RIVERS. I want to ask Mr. Wellborn a question for the record, and Mr. Buchanan.

Now your institute carries on research organization?

Mr. WELLBORN. Yes, sir.

Mr. RIVERS. It is an extensive one, Mr. Wellborn?

Mr. BUCHANAN. May I answer that, sir?

Mr. RIVERS. Yes, I directed the question to either of you gentlemen.

Mr. BUCHANAN. Yes, sir. Our research program is carried out under 3 classifications, that is, 3 phases. At College Park, Md., where we have headquarters offices and laboratories we concentrate our investigational work on asphalt mixture design. On asphalt as a material the research work is done at our member company laboratories. They have extensive research facilities. It represents really millions of dollars. They are better equipped to do the research work on asphalt as a material.

Mr. RIVERS. When you say member companies, do you mean the manufacturing companies?

Mr. BUCHANAN. Yes, sir, the asphalt producers who support the institute.

Mr. RIVERS. And they are part and parcel of your organization?

Mr. BUCHANAN. Yes, sir.

The third phase of our research program is carried out under sponsorship, you might say. We make grants to universities, who in the first instance are interested in certain things in which we are interested and have the know-how to go ahead and do it. We make grants to them to proceed in the usual university fashion of getting fellows and doing research work and publishing theses.

I couldn't give you a dollar value because I have no way of estimating the work done in our member companies.

Mr. RIVERS. I wanted the record to be replete on this part of it. The impression should not be gained that the Asphalt Institute expects the Government, that is, the Army engineers or the Air Force or any other subordinate branch of the Government, to carry on the

research and development of something which you say would be in its end product made available.

Mr. BUCHANAN. By no means. We carry our burden just to the extent of our facilities.

Moreover—if I might divert to the highway field right at the moment? The oil industry, of which we are a part, I believe is contributing some $800,000 to the heavy-duty road test over in Illinois, for example. But our own program on asphalt mixture designs is carried out at College Park.

Mr. RIVERS. Do you contribute anything to the Army engineers?

Mr. BUCHANAN. No, sir, we do not.

Mr. RIVERS. Do you offer them any specialized technical know-how?

Mr. BUCHANAN. We have made available our people to confer with them. We have not made any money contribution.

Mr. RIVERS. Yes. But you do carry on, in response to my inquiry, extensive research in the field of asphalt and asphalt paving, in all of its uses?

Mr. BUCHANAN. Yes, sir.

Mr. RIVERS. Now I want to ask Mr. Courtney, Mr. Chairman. I wish Mr. Courtney would look into the posibility of our affixing—Mr. Hess, I wish you would listen to this, too—some sort of an amendment to our public works bill that would protect us against the changing of a line item. And that is what happens. That is in any construction project. When they come to us and justify the line items for a base and go out and change the qualifications and the end cost, I think the committee should know about it before it is done. Now I don't know how the committee can set themselves up as contractors, but I think some knowledge should be brought to the attention of the chairman, Mr. Vinson.

Mr. HESS. That the Department notify——

Mr. HÉBERT. No; Mr. Rivers suggests the construction bill be so amended——

Mr. RIVERS. The bill that is coming up, our public works bill.

M. HÉBERT. That carries with it the amendment also reemphasizing the desire of the committee for bidding as opposite to negotiation. That amendment was put in by Mr. Kilday.

Mr. HESS. Mr. Kilday's amendment.

Mr. HÉBERT. Yes.

Mr. COURTNEY. See if I understand you correctly. Your point is that in the justification for the authorization a criterion is established, a base of a certain characteristic.

Mr. RIVERS. And so much——

Mr. COURTNEY. Is authorized at a price.

Mr. RIVERS. All right. And so much for runway paving.

Mr. COURTNEY. Correct.

Mr. RIVERS. Runway, estimated so much. It happens every day.

Mr. COURTNEY. That is right.

Mr. HÉBERT. That is in the bill in line items.

Mr. RIVERS. Line items. But whenever that thing is renegotiated and goes up as in the case of this one, 2 or 3 million dollars, there has been——

Mr. COURTNEY. The committee is not informed of that change, is your point, isn't it?

Mr. RIVERS. Certainly. And under this dispersal project, which we have been thoroughly indoctrinated on, on the B–52's and the B–47's, if carried to logical conclusions in all the bases, why the authorizations which we are going to defend on the floor in 2 weeks might be completely abrogated or circumvented. Do you get the point?

Mr. COURTNEY. Yes.

Mr. RIVERS. If carried to its logical conclusion. Because under this dispersal program, all bases may be made usable to these strategic aircraft, in case of emergency.

Mr. HESS. If the gentleman will yield?

That is probably one of the reasons of the Air Force coming back to the committee, during the consideration of the construction bill, and asking for increased amounts from previous years' authorizations, because they had changed the criteria.

Mr. RIVERS. They didn't do it in this case.

Mr. HESS. They did it in this case.

Mr. RIVERS. They didn't come back to the committee.

Mr. HESS. They came back to the committee in a number of instances.

Mr. RIVERS. They did not on this one.

Mr. HESS. I don't know whether they did that in this case or not. I don't recall.

Mr. HÉBERT. In the consideration by the full committee of the construction bill, emphasis was made by the witnesses on an all-rigid paving program. You recall it was discussed at length before the full committee.

Mr. RIVERS. For dispersal purposes.

Mr. HÉBERT. And indicated—not only indicated but testified to, because I asked certain questions along that line when I was present.

Mr. RIVERS. Yes.

Mr. HÉBERT. The expression was used and gave an indication that there were certain areas——

Mr. RIVERS. Critical areas.

Mr. HÉBERT. No; they didn't use the word "critical." They used the term "all-paving program." But under the questioning or breakdown, it was admitted by the witness at that time that in effect there was nothing left for asphalt at all. It was all concrete, except the roadway approach.

Mr. RIVERS. I didn't know that, because at that time I didn't know about all of this. Because I wasn't familiar with all of this as much as the chairman. But I think we should have more knowledge than we have had in the past on these things.

Mr. HÉBERT. We will explore that, Mr. Rivers. I think it is very pertinent here.

Mr. COURTNEY. On the construction bill.

Mr. HÉBERT. Mr. Gavin, do you have something?

Mr. RIVERS. On the construction bill.

Mr. GAVIN. On page 2, you state:

Exhibit 3 contains a statement attributed to Gen. Curtis LeMay to the effect that only two United States airfields, at Merced, Calif., and Limestone, Maine, are properly equipped to handle huge intercontinental bombers.

Now, in checking back the reference to exhibit C, that is exactly what General LeMay said.

Then you go on:

This exhibit includes pictures of these two airfields. Please note that they are largely constructed of asphalt.

Now, that to me implies an inference that General LeMay may be in favor of the flexible rather than the rigid, from what you say. The inference is there. He made the statement I think we ought to have General LeMay up here. I think his great experience on the B–47 and the B–52 and the B–36 would qualify us to give some opinions on the types of pavement we are considering here.

Mr. RIVERS. Isn't he in the city now?

Mr. GAVIN. Yes; he is in the city now. In view of the fact that his name was mentioned—and one could conclude from your statement that possibly General LeMay favors, because he made the statement that these two fields—and you say they are properly equipped to handle huge intercontinental bombers. He ended there. But you add:

This exhibit includes pictures of these two airfields. Please note that they are largely constructed with asphalt.

So that would, from my reading of it—my conclusions would be that possibly General LeMay is inclined to be friendly or favorable toward the flexible pavement.

Mr. WELLBORN. Mr. Gavin, that was not my intention, to infer in any manner that Gen. Curtis LeMay is favoring flexible pavement. I brought this point out simply to show that these two intercontinental bomber bases, which as I understand are the two primary B–52 bases in this country, are largely surfaced with asphalt and are adequately serving the missions.

Mr. GAVIN. But you did know it would be impressive if you used General LeMay's name there, in connection with calling this to the attention of the committee, that he said that they were the only two bases?

Mr. WELLBORN. Naturally, he is the authority in SAC.

Mr. GAVIN. That is why I think we ought to have him.

Mr. RIVERS. I thought—if the gentleman would yield. I didn't hear his testimony in 1954. But I thought in 1954 General LeMay said all he wanted was concrete; it was ridiculous to have anything else.

Mr. HÉBERT. He didn't testify in 1954.

Mr. RIVERS. Or whenever he testified.

Mr. GAVIN. Well, here are two bases——

Mr. RIVERS. Didn't he testify on this at some time?

Mr. GAVIN. No.

Mr. COURTNEY. Not before the subcommittee. I am not aware of that testimony.

Mr. RIVERS. Because I heard Mr. Cunningham—he is my source for that, that he understood him to say that. I would like to get him up here myself.

Mr. HÉBERT. Of course, any individual in the Air Force—If General LeMay is one of those individuals, I think he should be in the rebuttal or the explanation to these allegations made today. Because

at this particular time I think the hearing has taken a very definite turn, in which certain allegations and very serious allegations have been made. I think it is very important for the committee's benefit and for the American public's benefit to have all of this thrashed out and put right on top of the table. That was the reason the Chair instructed Mr. Courtney to notify the Air Force that the committee expects them to come in here with competent witnesses to answer each and every one of these allegations specifically.

And I agree with the gentleman from Pennsylvania, that General LeMay has been injected here, certainly in a persuasive attitude, by Mr. Wellborn. But I think as the commander of SAC he should be one of our witnesses.

Mr. BUCHANAN. Mr. Chairman, I believe the record for June 24 contains some speculation as to General LeMay's attitude favorable to concrete.

Mr. WELLBORN. I think this was one of the reasons we included this.

Mr. RIVERS. Yes.

Mr. BUCHANAN. This exhibit, to show. A check of the record would verify that.

Mr. HÉBERT. There is no better way to find out than the source itself.

Mr. WELLBORN. That is right.

Mr. GAVIN. You are going to ask that General LeMay appear?

Mr. HÉBERT. We shall ask General LeMay.

Mr. RIVERS. I feel more and more now that we should have started off with the asphalt people to start with, and then put the military on. It is like going to the courtroom and putting the defendant on first instead of the prosecution.

Mr. COURTNEY. I didn't consider it an adversary proceeding, Mr. Rivers.

Mr. HÉBERT. Mr. Rivers, you know, as you said, this is not conducted according to the rules of the court.

Mr. GAVIN. You say here, with reference to this Kelly test,

> The exhibit is self-explanatory, but I would like to go one step further and point out that if one were deliberately setting out to discredit asphalt pavement, he could set up no better situation than the Kelly test. There are conditions imposed in this unrealistic test.

As an assoication or an institute, did you suggest to the Department of the Army that in your opinion the Kelly test was not a fair test and that you would suggest the type of test that in your estimation was the kind of a test that should be conducted to reach some conclusions relative to rigid and flexible pavements?

Mr. WELLBORN. Since the Kelly test has been concluded, our organization has been invited in by the Corps of Engineers for cooperative work. Previous to the Kelly test, we were not.

Mr. GAVIN. Well, you did know that the Kelly test was going to be undertaken, didn't you?

Mr. WELLBORN. Yes, indeed.

Mr. GAVIN. You had some idea of what it was all about and what the tests were going to be. I imagine any institute such as yours would be informed on what is going on in the industry.

I am asking you the question: Did you go to them before they proceeded with the Kelly test and protest that you thought it was an unfair test?

Mr. WELLBORN. Mr. Gavin, at the time we weren't familiar with the design of the test, and we had no way. We have no way to get to restricted matters.

Mr. GAVIN. Well, the Department of Engineers have indicated that they wanted to cooperate with all elements in this particular field, to secure information to arrive at a conclusion. Why wouldn't you have injected yourself into the picture as an institute?

Mr. RIVERS. Mr. Gavin, will you yield there?

Mr. GAVIN. Yes.

Mr. RIVERS. The Department of the Army didn't conduct the Kelly test. It was the Air Force. The engineers didn't conduct that.

Mr. GAVIN. Well, regardless of the Army or the Air Force, why didn't you move in and say:

We don't think we are going to be given the kind of consideration that this important matter is entitled to by these tests and we would like to discuss it further with you before you proceed.

Mr. WELLBORN. Mr. Gavin, numerous times engineers from our organizations have called on the Corps of Engineers and the Air Force offering the assistance of our technical people in any problems that might arise on flexible pavements.

Our offers were not accepted until after the Kelly test was concluded.

Mr. GAVIN. Who did you make the offers to? Can you name the individual in the Department that you submitted your request to to give consideration?

Mr. WELLBORN. At the time we offered our assistance to the Corps of Engineers previous to the Kelly test, it was made to Colonel Troxler, and previous to that——

Mr. GAVIN. What did he have to say?

Mr. RIVERS. Where he is located and everything?

Mr. BUCHANAN. At that time, sir, if I may answer, he was Assistant for Engineering and Contracts, Military Construction, Office, Chief of Engineers. I believe he is now on a different assignment.

Mr. GAVIN. What did he say?

Mr. WELLBORN. He thanked us and said if he needed our assistance he would call on us.

Mr. GAVIN. We ought to have him, too.

Mr. HÉBERT. Yes.

Mr. BUCHANAN. Mr. Chairman, may I add a statement with respect to Kelly? I think one of the things that bothers us the most about Kelly is that the test was closed out when this distortion showed up. [Exhibiting piece of stone.] As you can see, again I say it was not a complete failure. It was a distortion undoubtedly related to the failure of the test. We have no doubt that distortion was made and the test continued. That is what any paying technologist would do. That is what any engineer would normally do. Our impression is that the Air Force closed out the test, whereas the Corps of Engineers would be happy to try again.

Mr. RIVERS. Now the Corps of Engineers—Mr. Chairman, I want to get it—was not in on the Kelly test?

Mr. BUCHANAN. I believe the Corps of Engineers was. I believe they conducted the test for the Air Force. That is my impression. They are here to testify.

Mr. RIVERS. Let's get that straight.

Mr. HESS. Mr. Foster is here, and he can get that straight.

Mr. BUCHANAN. My impression is the Corps of Engineers did it for the Air Force, but the Air Force was supplying the money and refused to continue the money for the necessary additional testing when this distress became manifest.

Mr. HÉBERT. We can clear that up wtih Mr. Foster.

Mr. COURTNEY. Mr. Chairman, Mr. Foster is right here.

Mr. GAVIN. In the original pouring, wouldn't you have been sufficiently interested, your institute, to see the formula was proper before the cement was laid?

Mr. BUCHANAN. Indeed we were.

Mr. GAVIN. You come up now and say it was an improper formula. At the time wouldn't you, in view of the fact that it meant so much to your industry, be right in attendance when this mix was being made and the formula was prepared, to see that it was properly prepared to get you the desired results that would mean so much to your industry?

Mr. BUCHANAN. Mr. Chairman, may I reply to that?

Mr. HÉBERT. Yes.

Mr. BUCHANAN. Indeed we were interested. As a matter of fact, we arranged for some of our people to be observers. We obtained samples of the materials. In our laboratory at College Park we ran some, what we call in asphalt technology, stability tests. We were alarmed that the stability tests we found in our laboratory were rather low, knowing this was going to be simulated B–47 traffic.

If my memory is correct, I believe we telephoned that information to Vicksburg. I am relying on my memory, but I believe that is correct.

Mr. WELLBORN. I recall that.

Mr. GAVIN. I wouldn't rely on your memory.

Mr. BUCHANAN. I believe it was telephoned, rather than put in writing. That is my point, That is evidence of our interest in this thing.

Of course, we were not running the test. We gave them our advice. We gave them the warning that our tests indicated low stability, which would be an advance warning that distortion might be expected under heavy loads.

Mr. GAVIN. That is what I would have done. I would have wired them right then and there, that in your information the formula now being prepared for this strip would not get the desired results according to our way of thinking and we merely want to protest.

Mr. BUCHANAN. We thought telephone was faster than wire.

Mr. GAVIN. That is all right. It isn't faster than wire when you come back here sometime later and you want to know specifically what you did or you did not do.

What I am concerned about: Why you didn't move at that particular time and say, "We don't think you are going to get the results desired. You are not following the formula. We just merely want to be recorded as protesting."

Mr. RIVERS. That is what he will do next time.

Mr. HÉBERT. Mr. Hess.

Mr. HESS. Let me attempt to clear this up. Did you know exactly what the Air Force was going to do when they laid this strip? Did you know the type of equipment they were going to use to test?

Mr. BUCHANAN. We didn't know all the technical details. We knew in general the nature of the test, there were going to be two sections in this taxiway, and it was going to be subjected to B–47 traffic. I think we were not aware of the fact that it was going to be subjected to continuous traffic at high temperature.

Mr. HESS. I think Mr. Wellborn stated that here.

Mr. BUCHANAN. Yes.

Mr. HESS. On page 3 of his statement he said:

> The Air Force required the asphalt pavement to be designed on the basis of criteria established with 1,500 coverages of accelerated test traffic."

And then on the following page he says: "The test traffic required at Kelly, however, was 30,000," so you didn't have all the facts.

Mr. GAVIN. You did say you had observers there and you did take some of the material and test it in your laboratories and you found and you felt it was not going to give the desired results.

Mr. BUCHANAN. An observer can't know all the details in the files and records on the materials tested.

The thing about Kelly is that in making all the tests in rapid order, all at high temperature—I believe it calculates out to something like the equivalent of one day of testing it, on this section at Kelly of prototype traffic, that would occur in intense operation over the period of a month, all at high temperature. But I would point out that on a regular airfield, all the operations of planes wouldn't be at high temperature and, therefore, the worst condition for asphalt pavement.

Neither, to take the opposite case, would all the operations at a regular airfield be at cold temperature or at conditions which might be most severe or adverse for rigid type.

In that respect, then, the test was not a direct comparison, despite the fact that two materials were placed in the same taxiway and subjected to the same load. They were subjected to different conditions.

Mr. GAVIN. I think that is a good observation. Now did you make that suggestion to the Department of the Air Force at that time?

Mr. BUCHANAN. I didn't personally make it, Mr. Gavin. I can't say whether or not our observer did.

But, again, I come to the point that we were dismayed that the test was curtailed or shut off when the distress showed, because by that way we were aware of these conditions and an adjustment of the mix and a continuation of the test would have resolved all the problems.

At that stage of the game we concentrated our interests in having the tests continued with correction in the mixture.

Mr. RIVERS. You knew what the mixture had before you went there, or was it not until you went to College Park you found out?

Mr. BUCHANAN. Say that again, sir.

Mr. RIVERS. I say were you aware of what that mixture was before the tests were concluded, before your laboratory——

Mr. WELLBORN. We were aware of what the mixture would be before the test was concluded.

Mr. BUCHANAN. I think so.

Mr. HÉBERT. So far as the telephone call was concerned.

Mr. RIVERS. After they got to College Park they made a telephone call.

Mr. BUCHANAN. Well, we had samples sent to us from Kelly to College Park. We made up mixtures in accordance with what we understood they were making at Kelly. We made our stability tests. We found them low. We became concerned. We telephoned the warning that we had observed these low stabilities.

Mr. RIVERS. That is my understanding. But you didn't know that until your College Park laboratory told you that?

Mr. BUCHANAN. That is right.

Mr. RIVERS. Is your testimony to the effect that you did not know what caused that running, until you took it to your laboratories, or knew of the component parts of that mixture?

Mr. BUCHANAN. We did not think the stabilities were low until we made the tests at College Park.

Mr. HÉBERT. I think in the interest of clarification—Mr. Foster is here and he could perhaps clear up some of the situation.

Mr. GAVIN. May I ask a question before Mr. Foster comes up?

Mr. HÉBERT. Yes.

Mr. GAVIN. Do you have, does your institute have, any tests that you could suggest could be made, what you consider a proper test?

Mr. WELLBORN. We follow the same test procedures——

Mr. GAVIN. Any program or plan?

Mr. WELLBORN. We follow the same test procedures as the Corps of Engineers. However, we have other testing techniques that we use, as well as highway departments. Many highway departments——

Mr. GAVIN. From your statement you don't seem to think much of the Kelly test at all?

Mr. BUCHANAN. Because it was a cycle test and when an error in the mixture was discovered it was not corrected and retested. This would be done on any paving project in the country. Any asphalt technologist knows that. But it was not done at Kelly.

Mr. WELLBORN. Mr. Gavin, a test usually is run by a technician to learn something, that is how to make something better. Destructive testing of a beam or anything else is not simply to destroy the beam, but it is to gain engineering knowledge. If the test at Kelly had been run to gain engineering knowledge, then surely the idea should have been to determine the proper asphalt content to withstand this channelized traffic under high pavement temperatures.

Mr. GAVIN. That is why I asked you why you didn't go to the Department of the Air Force and see that your recommendations were incorporated in their program.

Mr. WELLBORN. Mr. Gavin, that is much easier said than done, particularly when you——

Mr. GAVIN. You could have at least made them. If they didn't accept them, that would be a matter of record.

Mr. WELLBORN. We made recommendations.

Mr. GAVIN. When they are all trying to cooperate to find the answer to the problem. You say in your statement in effect the Kelly test was no test at all?

Mr. WELLBORN. That is still my opinion.

Mr. HESS. When was the Kelly test performed?

Mr. WELLBORN. It was performed in 1956.

Mr. HESS. When in 1956? Prior to May?

Mr. WELLBORN. May and June, as far as the flexible pavement was concerned.

Mr. HESS. Before or after the new criteria had been laid down?
Mr. WELLBORN. That was after the new criteria.
Mr. HESS. After the new criteria had been laid down?
Mr. WELLBORN. Yes, sir.
Mr. HESS. The Kelly test was performed?
Mr. WELLBORN. Yes, sir.
Mr. HESS. It would appear that the reason the Air Force did it was in order to back up the criteria that they laid down. Doesn't it seem that way?
Mr. WELLBORN. I would assume so.
Mr. HESS. Because all they did was perform this test. They made no effort whatsoever to correct the type of material that they were using at the time, in the test. They just let it go at that, and that was the end of it. I understand from the Corps of Engineers here, from Mr. Foster, that subsequent tests have been made by his outfit down there.
Mr. BUCHANAN. At Vicksburg.
Mr. HESS. At Vicksburg, yes.
Mr. BUCHANAN. But there was no attempt to correct the proportions.
Mr. HESS. Not by the Air Force?
Mr. BUCHANAN. No.
Mr. HÉBERT. Now, Mr. Buchanan, I understood you to say the basis of the Kelly test was 15,000 coverage.
Mr. WELLBORN. 1,500.
Mr. BUCHANAN. I believe Mr. Wellborn testified——
Mr. WELLBORN. 1,500 coverages.
Mr. HÉBERT. 1,500 coverages?
Mr. WELLBORN. Yes, sir.
Mr. HÉBERT. And actually it was 30,000?
Mr. WELLBORN. The criteria as I understand it from the Corps of Engineers, at the time of the design of the pavement at Kelly, was based on 1,500 accelerated coverages of the 100,000-pound load, at pavement temperatures above 90° F.
Mr. RIVERS. That is 1,500 landings?
Mr. COURTNEY. 1,500 crossings.
Mr. WELLBORN. This is coverages. This would be landing and take-off—I mean landing.
Mr. COURTNEY. Over what period of time?
Mr. BUCHANAN. Concentrated.
Mr. COURTNEY. What does that mean?
Mr. WELLBORN. Back and forth.
Mr. COURTNEY. As far as you can do it?
Mr. WELLBORN. Yes.
Mr. RIVERS. You were covering 1,500?
Mr. WELLBORN. Yes.
Mr. HÉBERT. Actually, how many coverages were made when the failure was discovered?
Mr. WELLBORN. 9,000, I believe.
Mr. HÉBERT. 9,000, sir; is that right?
Mr. BUCHANAN. In that order of magnitude.
Mr. HÉBERT. Well, I mean, give or take a couple.
Mr. BUCHANAN. Yes.

Mr. HÉBERT. Do you have any information—perhaps Mr. Foster should be the one to testify—as to the condition of the paving at 1,500?

Mr. WELLBORN. To my knowledge, no, sir.

Mr. HÉBERT. And it only broke down after 9,000?

Mr. WELLBORN. That is our understanding.

Mr. HÉBERT. So in other words, the Air Force kept experimenting until they broke it down, and said, "That is it."

Mr. HÉBERT. Mr. Foster, would you step up, please, sir, and clarify this a bit?

Mr. GAVIN. The chairman is the judge and the jury.

Mr. HÉBERT. Now, Mr. Foster, you heard the discussion. Can you help us?

Mr. FOSTER. I can——

Mr. HÉBERT. And tell us exactly what happened at Kelly?

Mr. FOSTER. There is one item—I am sure the Corps of Engineers conducted the Kelly test and not the Air Force. The Air Force asked for the test be conducted as a demonstration test to see if the then existing design for rigid and flexible was satisfactory, as a comparison between one and the other.

The Air Force specified nothing further than that it be the then existing criteria.

Our previous designs had been based on 1,500 coverages, that is of the asphalt-paving mixtures, that is 1,500 coverages of hot-weather traffic, because we felt that gives us a mix which was satisfactory for 5,000 coverages. In fact, we thought it was safer than necessary for 5,000 coverages, because under prototype traffic, that is under actual aircraft, we had not experienced any distress with the pavements which had been designed on that basis.

Mr. HÉBERT. Well, when you arrived at the 1,500 coverages, was it holding up according to your design?

Mr. FOSTER. When we reached a level of 1,500 coverages in the test at Kelly, the pavement was entirely satisfactory.

Mr. HESS. What about 5,000?

Mr. HÉBERT. When you reached 5,000, which was your maximum?

Mr. FOSTER. The distress was known to us by about 2,000 coverages. We knew it was coming. It started somewhere at around 4,000 and by 9,000 it had reached a significant figure, and we cut it off.

Mr. HÉBERT. So it did perform according to your design at 1,500?

Mr. FOSTER. It performed in accordance with the design at 1,500, but we anticipated it would do a lot better.

Mr. HÉBERT. But the point I am trying to make is that it did perform at your design?

Mr. FOSTER. Yes; that is right.

Mr. HÉBERT. According to what it was designed to test.

Mr. FOSTER. That is right.

Mr. HÉBERT. And anything in excess of that was giving an added burden to the design.

Mr. FOSTER. That is right. But, then, it was our responsibility to produce a pavement which would stand prototype traffic, which at that time we had agreed was something in the order of 30,000 coverages.

Subsequent to the Kelly test, that about 10,000 coverages of hot-weather traffic is satisfactory to develop designs which will stand 30,000 coverages of traffic all around the year.

Mr. HÉBERT. Do you know why the tests were not continued or why they were discontinued so abruptly after the distress in the flexible paving?

Mr. FOSTER. As soon as we knew we had the distress coming we contacted the engineers, the Office of Chief of Engineers, who we deal with, who we work for, and suggested it be replaced. They contacted the Air Force and reported back to us that the occupancy date of the airbase was approaching, and that the test could not be continued because the taxiway was needed for operations before we could complete the replacement and testing.

Mr. HÉBERT. So it was an arbitrary cutoff by the Air Force?

Mr. FOSTER. Well, the cutoff, as far as I know, was dictated by the Air Force, but I don't say it was arbitrary or not arbitrary.

Mr. HÉBERT. Well, as far as you were concerned, the Air Force called the tests off.

Mr. FOSTER. That is right.

Mr. HÉBERT. And were not interested in further getting the facts.

Mr. FOSTER. They——

Mr. HEBERT. They had gotten what they wanted and they were not interested in going any further than that. I am not saying you are saying that. I am saying that.

Mr. FOSTER. May I just sit silently?

Mr. HÉBERT. You can stand mute on that observation.

Mr. RIVERS. Could I ask Mr. Foster a question? I mean if it embarrasses you, don't answer it, Mr. Foster. Did it occur to you that the test at Kelly was being conducted under unusual heat conditions?

Mr. FOSTER. Sir, I presume that between myself and Mr. Turnbull we set up the tests at Kelly. At the time we set them up, it did not occur to us. Since then we have concluded that it was unusual.

Mr. RIVERS. Unusual.

Mr. FOSTER. That is backsight.

Mr. RIVERS. That is backsight.

So if you were to conduct a test to simulate a test similar to that of Kelly, you wouldn't have it under those unusual heat conditions?

Mr. FOSTER. The consideration of a repeat on a demonstration test has come up several times in our thinking, and we have concluded that we would not undertake such a test unless the traffic were distributed around the clock and around the year.

Mr. RIVERS. Around the clock.

Mr. FOSTER. In that case we would go to 30,000 coverages, which is the indicated amount of traffic that is needed.

Mr. RIVERS. You would take all degrees of temperature that you could expect during the calendar period?

Mr. FOSTER. That is right.

Mr. HÉBERT. I am going to ask you a question now, Mr. Foster, and you do not have to answer it.

I realize why you refused, or rather declined to answer it. I am not asking you to take the fifth amendment.

I am giving you all the amendments.

Would you be willing to say—and, mind you, I am not going to press you because I do realize the position you are in, but I do want to get the question in the record.

Do you think it was a fair test at Kelly?

Mr. FOSTER. I think that the application of the traffic all in hot weather would give a condition which would not simulate the prototype conditions, and on that basis——

Mr. HÉBERT. Say it in language I can understand.

Mr. FOSTER. On that basis, it would be unfair.

Mr. HÉBERT. On that basis it was unfair.

Mr. FOSTER. It was unfair.

But at the time I set up the Kelly test, I did not realize that. This statement is behind——

Mr. GAVIN. You had set it up with the best knowledge you had available?

Mr. FOSTER. The best knowledge.

Mr. GAVIN. With the facts and information at your disposal at the time.

Since then, you too, have learned something about it.

Mr. FOSTER. I have learned a lot.

Mr. RIVERS. It would be similar to taking a slab of concrete and testing it up at Thule, Greenland, or whever Thule is located.

Wouldn't that be about the same kind of a test?

Mr. FOSTER. Mr. Rivers, I don't know much about portland cement concrete. I would have to refer to Mr. Hutchison.

Mr. RIVERS. Well, that is all right.

You do know, though, that concrete reacts differently in very frigid temperature, with certain types of subsoil.

Mr. FOSTER. It is affected by temperature, but not to the extent that flexible pavement is.

Mr. GAVIN. What did you say?

Mr. FOSTER. I say, portland cement concrete is affected by temperature, but not to the same extent that flexible pavement is.

Mr. CUNNINGHAM. I am a little confused over this mixing demonstration and I wonder if we are getting to the real point of the issue.

As I understand it, it is necessary to have the proper mix to get the best bituminous or asphalt pavement; is that correct?

Mr. FOSTER. That is correct.

Mr. CUNNINGHAM. Well, isn't it also true it is necessary to have the proper mix to get the best concrete or cement pavement, and if that is not done, we are going to have defects in either one; wouldn't that be true?

Mr. FOSTER. Yes, sir; that is right.

Mr. CUNNINGHAM. You know enough about cement to know that you can mix it improperly and it will go into chuck holes and be defective, and everything else.

Mr. FOSTER. Yes, sir; I know that.

Mr. CUNNINGHAM. Now, at this particular time, at Kelly Field, there was information available as to the proper mix to use, but it was not—that information was not used; is that correct?

Mr. FOSTER. You mean on asphalt paving?

Mr. CUNNINGHAM. Yes.

Mr. FOSTER. No, sir; we did not have the information we have today. Had we had it, Kelly, I can assure you, would have been done better.

Mr. CUNNINGHAM. Well, the information that you did have—did you provide it at that time?

Mr. FOSTER. I used every bit of information that I had at the time Kelly was designed. I designed the best possible mix that was possible at that time. Today I can do a lot better.

I actually thought that the mix designs which were producing at that time would take this 30,000 coverages. It was based on the performance we had obtained under prototype traffic of airfields which were as old as 4 years.

Mr. CUNNINGHAM. Now, isn't it true that in times past they have had formulas for mixes of other kinds of pavement, like concrete, that were defective also and did not produce a good result?

The whole thing in both categories is subject to exploration and development. Would you say that is correct?

Mr. FOSTER. Yes; that is correct.

Mr. HÉBERT. The Air Force refused to explore further.

Mr. CUNNINGHAM. We have to get the Air Force to do its duty. Isn't that a part of the function of this committee?

I would like to ask Mr. Buchanan a question. You state here that 7 of the 10 most heavily traveled civilian airfields in the United States are largely paved with asphalt.

Would you name a few of those, sir? One or two of them.

Mr. BUCHANAN. The Civil Aeronautics Administration publishes a list each year. There have been some changes from year to year. But among those that I can recall are Midway in Chicago, LaGuardia in New York, Washington National here——

Mr. CUNNINGHAM. That is enough.

Now, I have another question:

Mr. RIVERS. Go down to No. 7 and I will tell you how right you are.

Mr. BUCHANAN. Charleston has been in and out from year to year.

Mr. CUNNINGHAM. It is out now, is that right?

Mr. BUCHANAN. I believe the last listing did not include Charleston, whereas a year ago it was in the list.

Also, for the record, may I say, that CAA lists two categories. They have 1 group of classification by 1 listing of traffic, and 1 classification by another list.

Mr. GAVIN. You are getting back to your monopoly. Then I would say that the commercial lines certainly don't indicate that there is any monopoly on cement, do they?

Mr. RIVERS. I might say Charleston is asphalt.

Mr. GAVIN. Wouldn't you say that?

Mr. BUCHANAN. Yes, it is.

No, sir, not for commercial airfields. There is no monopoly one way or the other.

Mr. HÉBERT. Because they are in business to make money.

Mr. BUCHANAN. These pavements have been decided in competition.

Mr. CUNNINGHAM. Mr. Buchanan, at the top of page 7 you have this sentence.

> And economy was never more important than it is right now to us in the United States.

Why did you put that in there?

Mr. BUCHANAN. I read the newspapers.

Mr. HÉBERT. You want to persist in that question?

Mr. CUNNINGHAM. I have a good question back of it.

Mr. BUCHANAN. I read the newspapers——

Mr. CUNNINGHAM. Do you believe that, did you put that in your statement simply because you have been reading the newspapers and you thought it would have some effect on this commmittee?

Mr. BUCHANAN. No, sir; we believe that.

Mr. CUNNINGHAM. Did you believe that last year and the year before?

Mr. BUCHANAN. Yes, sir.

Mr. CUNNINGHAM. Why is it more important today than any other year?

Mr. BUCHANAN. Because we are apparently in a tighter financial situation than we have been for some time in the past. The cost-price squeeze is tighter right now than it has been in some time.

Mr. CUNNINGHAM. Do you believe that or did the chamber of commerce convince you of that?

Mr. BUCHANAN. I don't read the chamber of commerce publications very much.

Mr. GAVIN. May I ask you a question?

Mr. BUCHANAN. Yes, sir.

Mr. GAVIN. Has your volume of business increased last year?

Let me ask you this. Say, the last 4 years.

How much has your volume of business increased and what profits have you made in the last 3 or 4 years?

Mr. BUCHANAN. Mr. Gavin, our institute has—as I indicated in my statement we have nothing to do with the commercial aspects of our business. We are strictly engineering, and research. So I can't answer——

Mr. GAVIN. We will take it industrywide.

Mr. BUCHANAN. I can't answer as to profits; with respect to volume, tonnage——

Mr. GAVIN. Yes.

Mr. BUCHANAN. The tonnage last year—I believe the figures are just out. It is about 18 million tons of asphaltic materials of all kinds were sold in the United States. The year previously, I believe the figure was right at 17 million.

Over a long period of time, the rate of increase has been, oh, 6 percent increase per year.

Reports so far this year, however, do not show a corresponding increase. This could be a reflection of the weather that has vitally affected large parts of the United States.

Mr. GAVIN. That enters into it, too.

Mr. BUCHANAN. Yes, sir.

Mr. GAVIN. But don't you think the volume will pick up the latter part of the year?

Mr. BUCHANAN. Another thing, Mr. Gavin——

Mr. GAVIN. Don't you think the volume will pick up from now on, to the end of the year?

Mr. BUCHANAN. In answer to that question, I should like to observe that housing is down somewhat at the present time, and therefore, use of asphalt in roofing and other house uses is off. I think it will pick up, to answer your question. Whether or not the increase this year or the improvement will correspond to previous years remains to be seen.

With the new highway program gradually picking up speed in the long run, it will pick up. It has to.

Mr. GAVIN. Well, there isn't any particular monopoly, though, in asphalt or concrete; you are both highly competitive.

Mr. BUCHANAN. Yes.

Mr. GAVIN. And naturally, you are trying to get the greatest volume you can.

Mr. RIVERS. I think both industries are solvent.

Mr. BUCHANAN. That is my understanding.

Mr. HÉBERT. Unless there are further questions——

Mr. MILLER. I shed bitter tears for them.

Mr. HÉBERT. Any questions, Mr. Courtney?

Mr. COURTNEY. Mr. Chairman, I have one question of Mr. Foster, so we will have it at one place in the record.

Mr. Foster, could you state for the record—you have already described the source of the criteria which is specified for the Kelly test being a prevailing criteria of the Corps of Engineers for use under certain conditions, of 1,500 loadings and the like.

Mr. FOSTER. Yes.

Mr. COURTNEY. Could you state for the record so we may have it directly before us, so far as its contribution to the state of the art and to an understanding of the technological requirements, what did the Kelly test prove and what did it not prove?

Mr. FOSTER. The Kelly tests proved to us that we had to change our then existing criteria, on asphalt paving mixes.

Mr. COURTNEY. And for what reason?

Mr. FOSTER. Because the then existing criteria gave us too much bitumen in the mix for channelized traffic of B–47 loading.

Mr. COURTNEY. And for what traffic, what volume of traffic?

Mr. FOSTER. Channelized traffic.

Mr. COURTNEY. Well, in what volume?

Mr. FOSTER. The word "channelized traffic" to me means 30,000 coverages.

Mr. COURTNEY. 30,000 coverages. Is that all it proved?

Mr. FOSTER. Well, it proved also that we had a subgrade, subbase, and base which met our concepts of being satisfactory. It is true that it only carried 9,000 coverages, but there was so little distress, we were confident that it would have carried the traffic had the surface stayed intact.

Mr. COURTNEY. Maybe this is an unfair question, but what did it fail to prove, in the tests which were applying?

Mr. FOSTER. Again let me drop back to the word "demonstration." A demonstration test is different from an experimentation in our terminology. A demonstration test is to prove the adequacies or nonadequacies of something. In an experimental test we would have several items in there which would have different variables in them. Kelly only proved that the mix—the only thing that——

Mr. COURTNEY. What did it fail to prove, or did not prove?

Mr. FOSTER. I don't know offhand what to say, that it failed to prove. I don't know.

Mr. COURTNEY. Well, would this be correct to say, that in an experimental test, to give validity to the test as a whole, so far as it would contribute to the art of pavement design, you would have had to have

more variables in the test and that you would have had to substitute materials, different types of compaction, perhaps, and different types of material, at various levels, in order to get a true test.

Mr. FOSTER. For true experimental test, that is right.

Mr. COURTNEY. In order to prove the validity of your whole concept of pavement design; isn't that right?

Mr. FOSTER. Well, a demonstration test can prove the validity of the design—can prove or disprove it.

Mr. COURTNEY. Prove or disprove it, plus or minus, but it can't prove what might be done to correct the situation.

Mr. FOSTER. It doesn't tell which way to go—or how far to go. It tells you which way, but not how far.

Mr. COURTNEY. The Kelly test failed to prove or demonstrate to you what direction you might have to choose in order to rectify the conditions that showed up.

Mr. FOSTER. Well, it failed—I can say this. It failed to prove how far we had to go. It proved the direction.

Mr. COURTNEY. That is right.

Mr. FOSTER. And then the subsequent tests at Vicksburg, which were conducted the same summer, told us how far to go.

Mr. COURTNEY. How far to go?

Mr. FOSTER. That is right.

Mr. COURTNEY. But is it correct also to say that the Kelly tests, so far as breakdown was concerned, were confined to the bituminous overlay, or the surface, if you please?

Mr. FOSTER. Confined to the bituminous pavement; yes, sir.

Mr. COURTNEY. Confined to the bituminous pavement material itself.

Mr. FOSTER. Yes, sir.

Mr. COURTNEY. The surface.

Mr. FOSTER. That is right. Confined to this one here.

Mr. COURTNEY. Yes.

Mr. BUCHANAN. To this cross section [holding sample].

Mr. COURTNEY. That is all I had.

Mr. HÉBERT. Thank you, gentlemen, very much.

The committee will stand in recess until Monday morning at 10 o'clock, at which time we will have the witnesses for the Portland Cement Association.

Mr. COURTNEY. That is correct.

Mr. HÉBERT. That is all.

(Whereupon, at 3:15 p. m., the subcommittee adjourned to reconvene at 10 a. m. on Monday, July 1, 1957.)

AIRSTRIP PAVING MATERIALS

MONDAY, JULY 1, 1957

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE FOR SPECIAL INVESTIGATIONS,
Washington, D. C.

The subcommittee convened at 10 a. m., Hon. F. Edward Hébert, chairman of the subcommittee, presiding with the following members present: Mr. Hess, Mr. Brooks, Mr. Gavin, Mr. Cunningham, Mr. Fisher, and Mr. Bates.

Mr. HÉBERT. The commitee will be in order.

Mr. COURTNEY. Mr. Chairman, we have the Portland Cement Association this morning. In th center is Mr. G. Donald Kennedy, president. Mr. Kennedy is a registered civil engineer for the District of Columbia. He graduated from the University of Michigan, and is a former highway commissioner of Michigan and has numerous other distinctions to his credit.

We have Mr. A. A. Anderson on his left, chief paving consultant, for the institute. Mr. Anderson is a graduate of Kansas State College, a naval officer during the war, and has many other distinctions.

On the right of Mr. Kennedy is Mr. Gordon K. Ray, consulting airport engineer for the institute, who is a graduate of the University of Illinois, and has other distinctions to his credit, all of which are set out in his presentation to be made to the committee.

Now, Mr. Chairman, Mr. Kennedy has a prepared statement. Are you prepared to proceed, Mr. Kennedy?

Mr. KENNEDY. Yes.

Mr. COURTNEY. Mr. Chairman, I take it he may proceed in order without interruption until he completes his presentation?

Mr. HÉBERT. Yes; I will ask the committee members to cooperate and not interrupt until he completes his statement.

TESTIMONY OF G. DONALD KENNEDY, PRESIDENT, PORTLAND CEMENT ASSOCIATION, ACCOMPANIED BY A. A. ANDERSON, PAVING CONSULTANT, AND GORDON K. RAY, CONSULTING AIRPORT ENGINEER

Mr. KENNEDY. Mr. Chairman and members of the committee, our presentation is a prepared statement. After the title page we have a brief statement about the work of the association, which I will pass over.

(The information referred to in the statement is as follows:)

THE PORTLAND CEMENT ASSOCIATION

The Portland Cement Association is a national nonprofit organization voluntarily supported by over 70 member companies that manufacture portland cement in the United States and Canada. Its headquarters are in Chicago.

The association's work consists of scientific research, development of new products, promotion, educational work, and technical engineering service for improving and extending the uses of concrete.

To carry out this work the association maintains a headquarters staff of more than 300 scientists, professional engineers, and other specialists, and a field organization of more than 400 engineers, architects, and others working out of 32 district offices.

These men are in daily touch with design, construction, and maintenance problems throughout the country.

The association is in no way engaged in the manufacture, pricing, or sale of cement, and has nothing to do with commercial practices.

Representing the Portland Cement Association:

G. Donald Kennedy, president, registered civil engineer No. 234, District of Columbia; civil engineering graduate, University of Michigan; former State highway commissioner of Michigan; former vice president, Automotive Safety Foundation; former president of the American Association of State Highway Officials; member of the Highway Traffic Advisory Committee to the War Department, 1942–45; chairman of the Highway Research Board of the National Academy of Sciences, 1954–55.

A. A. Anderson, chief paving consultant; civil engineering graduate, Kansas State College; naval officer during World War I; former division engineer in Kansas State Highway Department; member, American Concrete Institute; Arthur M. Wellington Prize, American Society of Civil Engineers in 1950.

Gordon K. Ray, consulting airport engineer; civil engineering graduate, University of Illinois; officer, Corps of Engineers, World War II; coauthor Influence Charts for Concrete Pavements, the basis for present-day airfield pavement design; member, American Association of Airport Executives; registered professional engineer in Illinois.

Mr. KENNEDY. Mr. Courtney has introduced the three members of our team here.

I might say, incidentally, that it is the same team that appeared before you 3 years ago.

The next page is an outline of our testimony, and then we come to the statement itself.

Mr. Chairman, and members of the committee, thank you for the invitation to appear again before this committee. We welcome this opportunity to point out the economies that may be realized through the use of portland-cement concrete pavement for airfield construction. The information which we will present has been obtained from authoritative and published sources. It is a privilege and a very great honor to be here.

1954 hearings: In February 1954, I appeared before this committee to present some of the important reasons why concrete is the paving material essential for military airfields.

Review of association testimony: The fact that only concrete resists jet heat and blast was demonstrated and the disintegrating effects of jet-fuel spillage were discussed. The safety features of concrete pavement—better visibility, uniform durable skid resistance, both wet and dry, and freedom from loose particles—were discussed.

In addition, data were submitted to prove the economy of concrete pavement, its longer service life and lower maintenance cost, as well as the savings in planes and crews resulting from fewer accidents and freedom from costly operational interruptions.

COMMITTEE FINDINGS

After careful evaluation of all evidence presented, the committee ruled that the use of concrete in the critical areas, as defined by the Air Force and Navy, was justified and should continue. The committee's judgment contributed lasting benefits to the Nation's defense.

Now, over 3 years of additional experience with concrete pavement for airfield installations have confirmed both the superiority of concrete pavement, and the wisdom of previous decisions of this committee. These changes of the rapidly developing air age now indicate that the use of concrete should be extended to those areas formerly characterized as noncritical.

DEVELOPMENTS SINCE 1954

Changing aircraft design: In 1954, the world was on the threshold of a new era in aircraft performance. Each new generation of aircraft has made more exacting demands upon airfield pavements. Despite these rapid developments, concrete pavements in service in 1954 and those built since are the only airfield pavements that have successfully met operational requirements. In 1957, we see even greater effort devoted to advanced aircraft design. Concrete will continue to meet the requirements of more advanced types of aircraft, both military and civil.

ADAPTABILITY OF CONCRETE

These changes in design have brought about changes in operation which have imposed new demands upon airfield pavement. But, condition surveys of concrete in service and full-scale pavement tests have all confirmed the adaptability and superiority of concrete to meet these new demands. The same special properties of concrete that previously made it essential for the then-called critical areas now make it the only pavement suitable for all areas on military airfields.

Because of its inherent adaptability to changing aircraft design and new operational requirements, concrete pavement establishes the highest standards of safety and economy. This adaptability makes possible increasing the structural load-carrying capacity of the pavement by overlaying existing concrete with added thickness as planes increase in size and weight.

COST OF NONCRITICAL AREAS COMPARED TO THE TOTAL AIRBASE INVESTMENT

This hearing is concerned with the need for concrete pavement in the so-called noncritical areas. An examination of the component parts of an airbase is necessary to properly consider the values involved.

Components of an airbase: A modern military airbase, such as is demonstrated in No. 1, and we are showing here and which is included in the text in black and white, is a vast complex containing many features; housing, community buildings, training facilities, warehouse areas, fuel storage, hangars, operational facilities, parking

lots, streets, and airfield pavements. The total cost of a base suitable for the Strategic Air Command is in the vicinity of $100 million.[1]

You will note that many of these facts that are cited here are footnoted here, as to their source. The sources that we refer to are all here available to the committee.

Airfield pavement: The airfield pavement which is shown here on the overlap to the chart, at such a heavy-duty base, runways, taxiways, aprons, hardstands, and other special use areas, costs about $17 million, 17 percent of total base-construction cost.[2]

(The charts appear on the following pages.)

Noncritical areas: The so-called noncritical areas, chart No. 3, runway interiors and taxiways, make up about 20 percent of the total pavement area at a typical base or 3.4 percent of the total airbase cost.

The possible savings in first cost between concrete and flexible pavement in noncritical areas is a small percentage of the cost of the total pavement, and an even smaller percentage of the cost of an airbase.

Cost of noncritical areas compared to aircraft cost: Cost of either type of pavement varies from base to base, depending upon many local factors. Among local factors affecting bid prices are the subgrade strength, the availability of materials, the availability of qualified contractors, the size of the project, and the local labor force.

Concrete is sometimes lower in first cost than flexible pavement. If a first-cost differential does exist in favor of flexible pavement in noncritical areas, and the possibility of such a differential decreases with each new change in designs and specifications for asphalt, it is still a relatively small percent of the total cost of a base.

For a small possible difference in the airfield-construction cost, the safety of jet fighters, chart No. 4, worth $1,500,000 and B–52 bombers valued at $8 million each, is jeopardized. The total value of the 50 to 100 such aircraft which would be stationed at an airfield far exceeds the construction cost of an entire base or several such bases.

To evaluate the requirement for concrete pavement in these so-called noncritical areas, the nature of operations on these sections must be carefully considered. It is in these areas that the pavement does have the greatest effect upon the safety and economy of aircraft operation.

The changes that have occurred in modern military aircraft have brought about drastic changes in these operations. Today, the noncritical areas have, in fact, become critical. But before discussing the noncritical areas, a review of the basic reasons why concrete is used exclusively in critical areas is in order (chart No. 5).

NEED FOR CONCRETE IN CRITICAL AREAS

Effect of plane on pavement: The critical areas, as they are now known, runway ends, aprons, and warmup pads, were earlier classified as critical because of the serious effect which older and less powerful jet aircraft had on pavement in these areas. It was here that jet blast, fuel spillage, and wheel loads damaged asphalt pavement.

[1] Two Bases for the Biggest Strategic Bombers, Engineering News-Record, February 28, 1957, p. 40.

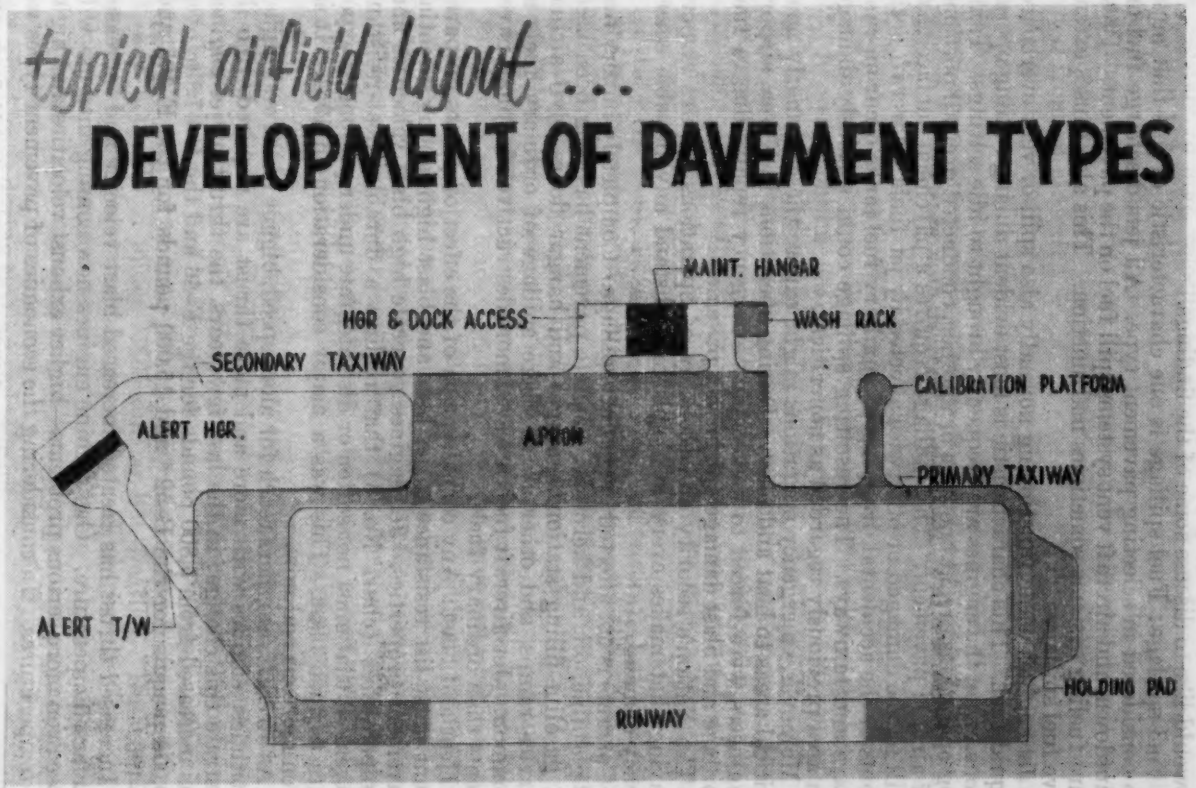
[2] Systematized Maintenance of Pavements, by L. B. Crowley, USAF, Proceedings—Tactical Air Command Pavement Maintenance Conference, December 1956.

typical airfield layout ...
DEVELOPMENT OF PAVEMENT TYPES
MAINT. HANGAR
WASH RACK
CALIBRATION PLATFORM
HOLDING PAD
H&R & DOCK ACCESS
APRON
PRIMARY TAXIWAY
SECONDARY TAXIWAY
ALERT H&R.
ALERT T/W

Typical airfield layout ...
DEVELOPMENT OF PAVEMENT TYPES
MAINT. HANGAR
WASH RACK
CALIBRATION PLATFORM
HGR & DOCK ACCESS
PRIMARY TAXIWAY
SECONDARY TAXIWAY
APRON
ALERT HGR.
RUNWAY
HOLDING PAD
ALERT T/W

typical airfield layout ...

DEVELOPMENT OF PAVEMENT TYPES



The effects of planes on pavement were discussed at length at the 1954 hearings and have since been the subject of many competent detailed studies. The results of these studies are now available, and I would like to discuss some of the findings.

Fuel spillage: Fuel spillage is one characteristic of jets that must be considered in selecting pavement type. All jets discharge fuel on shutdown, and aircraft vent systems spill fuel on the pavement. Pressure-fueling systems sometimes malfunction. This also causes extensive fuel spillage.[3]

Jet engines while functioning normally also spill or vent overboard liquid fuel. This characteristic is most evident during taxiing operations, when the engines are frequently brought to idle settings. Taxiing operations are, at one time or another, conducted over all portions of airfield pavement. This spillage requires a pavement surface that will not be damaged or otherwise affected by jet fuels. Aircraft accidents or the accidental dropping of auxiliary fuel tanks occur on runways and taxiways. The resulting spillage could seriously damage an area previously regarded as noncritical.

Moreover, emergency operations might expose these formerly noncritical areas to heat and blast. During operations in Korea, airport engineers were forced to make many emergency repairs due to fuel spillage and blast damage on runway pavement.[4]

The Nation's security and economy of operations require airport paving that makes every inch able to withstand any possible emergency demand.

Concrete is not affected by jet-fuel spillage. Completely impervious to gasoline, oil, and kerosene, concrete pavement has long been used in gasoline-filling stations, garages and hangar floors, civil airline service ramps, and other areas where spillage of ordinary fuels is common. Jet-aircraft fuels are even more destructive of asphalt pavements than ordinary fuels.

Heat and blast: Any consideration of the effect of planes on pavement must list resistance to jet heat and blast high among essential pavement properties. Jet engines generate high blast velocities and temperatures (chart No. 6) that require a durable, heat-resistant pavement that must not soften or distintegrate under prolonged exposure to such blast. This was a major consideration in 1954. It is even more crucial now.

As aircraft designers reach for more speed, bigger loads, and higher altitudes, engines with more and more thrust are required. To illustrate this change: in the last few years, the thrust of jet engines has increased from 5,800 pounds for the F–86 and the B–47 [5] to over 10,000 pounds for the B–52 [6] and 15,000 pounds for the F–105 and F–106.[7]

Increased thrust has created increased blast velocity and increases surface temperature. Gas turbine engines now coming into use will pose even more serious problems—higher exhaust velocities and higher temperatures. In considering the economies of pavement types we

[3] Report of Special Committee on Effects of Military Aircraft on Airfield Pavements, Highway Research Board, August 1955, p. 46.
[4] Jets and Asphalt—They Don't Mix, by William J. Geary, Pittsburgh Engineer, November 1953, p. 10.
[5] U. S. Military Aircraft, Aviation Week, March 15, 1954, p. 196.
[6] U. S. Military Aircraft, Aviation Week, February 25, 1957, p. 223.
[7] J–75 Turbojet Unveiled, Aviation Week, May 20, 1957, p. 28.

need only look to the immediate future for additional requirements for pavement durability.

Experience at Navy and Air Force fields has proved that concrete is resistant to high velocity blast and to high surface temperatures generated by turbojet engines. Laboratory investigations and full-scale research projects by the Navy, Air Force, and Bureau of Standards show that concrete can be built economically which will withstand exposure to blast temperatures far in excess of any now anticipated from jet aircraft.

Weight of plane and tire pressure: Military and civil airplanes are increasing in weight. Greater wheel loads and higher tire pressures may even make greater demands upon pavements than expected even 3 years ago. The pavement must carry the traffic of these heavier planes. It must support heavy-wheel loads without failure and must resist the tremendous load concentration of high-pressure tires.

In 1954, pavements were designed and built for the 200,000 pounds B–47 (chart No. 7) with 190 pounds per square inch tire pressure. Its 100,000 pound landing gear load was applied to the asphalt pavement which quickly failed in the 1956 test at Kelly Air Force Base.[8]

Today, pavement must be designed and built for the newer B–52. This gigantic bomber weighs 460,000 pounds. Its 240,000 pound (120 tons) landing gear load and 240 pounds per square inch tire pressure represent an increase of 14 percent in load and a 25 percent increase in tire pressure over that used in the Kelly test.

In 1954 the F–84, F–86, and F–89 fighter aircraft had tire pressures in the vicinity of 200 pounds per square inch. Today, the F–100A has 222 pounds per square inch, the F–84F has 240, and the F–101A has a tire pressure of 273 pounds per square inch. It is expected that these pressures will continue to rise. Tire pressures on some Navy fighters are now in excess of 300 pounds per square inch.

Increasing wheel loads and tire pressures have imposed new demands on airfield pavements, and created new requirements for performance. The pavement must be rigid and strong enough to resist these highly concentrated loads. The surface must not deform, rut, shove, or scuff under landing impact of these hard tires and heavy moving loads. The pavement must also possess structural strength to carry the load without failure of either the pavement or the supporting subgrade.

Now, I want to add one sentence to the prepared text.

Testimony before this committee has indicated that future planes may have a gear load of 325,000 pounds. Concrete is the only material that meets all of these requirements. It is a rigid, nonflexible material providing an ideal pavement for high pressure airplane tires. It does not deform under loads during hot weather. Ruts or depressions do not form in concrete under standing aircraft.

Concrete becomes neither tacky or sticky due to high temperatures and therefore does not scuff during locked wheel turning movements. Lack of deformation means there is a minimum of resistance to rolling wheel loads during taxiing and take off.

A concrete pavement is a precisely engineered structure. Concrete pavement design has been proved by full-scale field tests and labora-

[8] The Search Is on for Sturdier Asphalt Runways, Engineering News-Record, November 15, 1956, p. 27.

tory investigations, and verified by the performance of literally tens of millions of square yards of airfield pavement now in use.

The thickness of concrete required for any load, subgrade and operating condition can be determined accurately in advance of construction. Engineers are agreed on concrete pavement design methods. No such uniform agreement has been reached on flexible pavement design.

One primary function of a pavement is to distribute wheel load over the subgrade so that at no point is the pressure greater than the capacity of the subgrade to support the load. Concrete is the only pavement having the beat strength to do this.

Test data (chart No. 8) prepared by the Corps of Engineers shows a comparison of pressure distribution under two pavements. The pressure on the subgrade under a 39-inch flexible pavement is 37 pounds per square inch.[9]

Similar tests on a 20-inch concrete slab under the same wheel load indicated pressures less than 4 pounds per square inch.[10]

The accuracy with which engineers can determine these subgrade pressures under concrete in advance is essential to provide adequate and economical pavements for the constantly increasing wheel loads of military aircraft.

Channelization: One of the recent developments which has had a serious impact on the selection, design and construction of air field pavement is channelization of traffic.

It is primarily on the taxiways that channelization of traffic develops. The pilots of the heavy B–47 and B–52 bombers must glide their planes along the yellow center strips on the narrow taxiways in order to keep wing outrigger wheels on paved shoulder areas. The outrigger wheels are needed because the wheel assemblies of the main landing gears are placed in bicycle fashion one directly behind the other.

This need to follow a line results in a concentration of traffic and pavement loading in a very narrow band in the center of the taxiway.

In addition, the bicycle-type landing gear system on these planes causes two load repetitions on the pavement for each aircraft that passes. Thus, these newer type aircraft cause six times as many cycles of stress in the narrow channel in the center of the taxiway as did earlier aircraft.[11]

Channelization of traffic caused deep ruts and structural failure in flexible pavement and prompted the full-scale traffic load tests conducted in 1956 at Kelly Air Force Base, Tex.

Surveys of concrete taxiways built before the advent of channelization in service at SAC bases indicated that while there was some evidence of overloading on the older slabs designed for lighter aircraft and no channelized traffic, there still was no serious distress—no rutting or deformations to interfere with traffic.

Concrete taxiways are continuing to carry this more concentrated traffic at many bases with no interruptions to operations.

Concrete pavement can be designed and built economically to be

[9] Accelerated traffic test at Stockton Airfield, Stockton, Calif. (Stockton Test No. 2), Sacramento district, Corps of Engineers, May 1948, plate 177.

[10] Final Report—Lockbourne No. 2—Experimental Mat. Rigid Pavement Laboratory, Corps of Engineers, May 1950, p. 175.

[11] Heavy Wheel Load Traffic on Concrete Airfield Pavements, by Mellinger, Sale, and Wathen, Corps of Engineers, Highway Research board meeting, January 1957.

adequate for any channelized traffic. Concrete design takes into account the number of load repetitions anticipated for any aircraft.

The accuracy of concrete design for channelized traffic was successfully checked in full-scale pavement tests at the Corps of Engineers' Rigid Pavement Laboratory at Cincinnati and in the test at Kelly Air Force Base.

The ultimate economies resulting from the favorable performance of concrete in these tests will continue to provide important savings to the public.

URGENT OPERATIONAL NEED FOR CONCRETE IN SO-CALLED NONCRITICAL AREAS

Up to this point the important factors connected with the effect of military aircraft on airfield pavement have been discussed. The effect of aircraft on pavements was a primary consideration at the 1954 hearings. Today there is an even more important economic and safety factor to be considered in the so-called noncritical areas.

Effect of pavement on plane: The effect of the pavement on vastly more expensive aircraft (chart No. 9) and on the safety of aircraft crews is reaching staggering proportions. These men, trained at great expense, are not expendable.

In considering effects of pavement on the planes, we are considering pavement properties which affect safety. Safety is inseparable from efficiency of operation and efficiency is reflected directly in reduced cost of operation. Nowhere is safety of greater importance than on the high-speed runways and taxiways. These are the so-called noncritical areas.

Visibility: Concrete's high visibility (chart No. 10), day and night, is an important factor for pilots and for pilot trainees. The importance of visibility to a pilot should be emphasized. This makes his job of getting into the runway and staying there easier. The necessity for all-weather operations in the Defense Establishment makes visibility more important. The high speeds, heavy loads, and complexity of modern aircraft operations make split-second decisions imperative.

Concrete, because of its natural light color and its high reflectance of artificial light, has maximum visibility. This safety factor is an integral, permanent, part of the pavement. Tests by the Navy Medical Research Institute of various runway surfaces dramatically show concrete reflectivity averages more than twice as high as asphalt surfaces.[12] The same report shows this higher average reflectivity increases visibility even more markedly.

The greater visibility of concrete runways has long been acclaimed by pilots. This has been officially made a matter of public record by the Airline Pilots Association.[13] Representatives of the pilots association also have gone on record as requesting that only concrete be used on runways—the entire runway—for safety's sake.[14]

Skid resistance: Another pavement property to be carefully considered as a matter of safety when measuring the effect of pavement on the plane especially in noncritical areas is skid resistance (chart No. 11) or stopping distance.

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[12] The Visibility of Airport Runways, by Capt. N. L. Barr, Lt. (jg.) T. A. Haussman, and Lt. (jg.) J. F. Parker, U. S. Navy, Society of Automotive Engineers, April 1956.

[13] Suitable Airports From an Airline Pilot's Viewpoint, Capt. Barton Hewitt, TWA, transcript—1954 American Association of Airport Executives, May 1954, p. 33.

[14] Runway Construction at O'Hare Field, Airline Pilots Association, May 2, 1955.

Skid resistance of the pavement surface, or friction between tire and pavement, is most important on runways and taxiways. During takeoff and taxiing, as well as landing, control of the aircraft depends to a large extent upon skidfree contact between tire and runway surface. Controls used in flight are not sufficiently effective until flying speed is approached. On the ground the pilot must depend largely upon his brakes and steerable forward landing gear to remain on the runway. A slippery pavement is hazardous.

Excellent skid resistance is an inherent characteristic of concrete. The texture built into the surface at the time of construction insures excellent skid resistance for the life of the pavement. Airline pilots have testified to this fact.[15] They list skid resistance of runway surfaces as one of the most important safety features. Accidents have been attributed to slippery runways constructed of other materials.[16]

The ability to stop a plane on an airfield runway is of even greater significance with jet aircraft. They must rely almost entirely on brakes since there are no reversible propellers. Pilots have confidence that they can stop safely on concrete whether the pavement is wet or dry, in hot weather as well as in cold.

Surface alinement: Another factor in the effect of pavement on plane is surface alinement. Surface alinement is now of critical importance because of new aircraft designs and speeds.

Pavement surfaces on runways and taxiways must be level and even for operation of high speed jet aircraft. Small bumps, waves, or other irregularities in pavement surface have a serious effect on the aircraft and its performance. Such irregularities in the surface of runways and taxiways cause a rocking motion of the plane to set up vibrations which damage delicate electronic instruments, overstress the airframe structure and seriously affect pilot control of the aircraft. At the high takeoff and landing speeds necessary today this is a matter of vital importance to safe and economical operations.

The porpoising or galloping that has developed on rough asphalt runways demonstrates the costly effect of pavement roughness on aircraft. Figures have been released showing that takeoff speeds of new aircraft are in excess of 150 miles per hour. At this speed, the aircraft travels 220 feet per second. Surface irregularities disturb the equilibrium and stability of the plane. A plane surface for taxiways and runways is vital to the pilot's control of aircraft during high-speed operations.

> A pilot taxiing a plane at 100 miles per hour—and many of them land faster than that—must endure plus or minus 2½ G's of pressure from the vibrations of the plane alone. It is no wonder that the Air Force wants to do everything possible to cut down causes of motion and vibration. Unevennesses in runways can mean the repeated loss of valuable equipment and priceless lives of highly trained air crews.[17]

Concrete is the only pavement which can be built to the strict surface tolerances required for safe operation of today's planes. Built to an even plane, it retains its alinement with no ruts or bumps developing under concentrations of channelized heavy wheel loads. The effects of airplanes on pavement, and the consequent effect, in turn, of

[15] Airport Problems From the Pilot's Viewpoint, T. J. Linnert, ALPA, transcript—1956 American Association of Airport Executives, April 1956, p. 65.
[16] Aviation Week, February 6, 1956, p. 95.
[17] The Construction Job Ahead, by Lieutenant General Sturgis, Corps of Engineers, Associated General Contractors meeting, February 1956.

damaged pavement causing costly aircraft damage or accidents, is a most significant factor in judging pavement economy.

Engine damage from loose particles: Jet engine damage from pavement particles is another highly important effect of pavement on plane. Loose objects on pavement surfaces are a serious hazard to jet operations. Foreign objects entering jet engine intakes cause such serious damage to engine compressors that a costly complete engine replacement is required.

It is estimated that 40 to 50 percent of USAF engine replacements result from damage due to foreign particles entering the compressors. The $200,000 jet engine is in common use today and this is a major item that must be included when considering pavement economy. In fiscal year 1956, alone, the estimated cost of repair and replacement of engines damaged by foreign objects picked up from the pavement was over $8 million.[18] Since it is widely known that the predominant damaging agent is listed as small stones, the importance of pavement type cannot be overemphasized.

Concrete is free from sand, chips, or loose stones that may be loosened by jet or propeller blast or kicked up by the nose wheel of an aircraft and then be picked up by a jet engine. The even, rigid surface of concrete is clean and easily swept free of foreign particles.

IMPORTANCE OF MAINTENANCE AND OPERATIONS

Still another factor vitally concerned with economy is maintenance. No pavement yet designed has been so perfect as to eliminate all maintenance. But experience shows that the durability of concrete greatly minimizes the need for expensive maintenance. Where major maintenance is required, delays in training schedules can easily cause dollar losses running to many times the investment for all installations at a given field. Even in peacetime, this is expensive. For example, most modern bomber installations have only one runway. Shutting down this runway for maintenance may mean shifting an Air Force unit away from its base for periods ranging from weeks to months, with a consequent delay in meeting costly training schedules.

In time of national emergency, however, extensive paving failure requiring major maintenance would be not only expensive but could well be catastrophic. The need for constant operational readiness of our Defense Establishment and ability to operate uninterruptedly during wartime are of paramount importance. Therefore, the only economical pavement is one fully usable at all times, under all foreseeable circumstances, with a minimum attrition of men and planes.

For these reasons, the findings of the special Highway Research Board Committee study on the effect of military aircraft on airfield pavements that initial construction costs must not take precedence over operational requirements are of special significance.[19] The trained officers and engineers of the Air Force, Navy, and Army are in a better position to determine these operational requirements for the most important segment of our defense than any other men in the world. These dedicated men alone have the opportunity to properly

[18] Systematized Maintenance of Pavements, by L. B. Crowley, USAF, proceedings, Tactical Air Command maintenance conference, December 1956.

[19] Reprint of Special Committee on Effects of Military Aircraft on Airfield Pavements, Highway Research Board, August 1955, p. 6.

evaluate and analyze all the essential factors: construction costs, maintenance costs, operational costs, safety, and, above all, the ability of the installation to fulfill its defense mission.

The foregoing charts help point up the highly important differences that exist between the operational performance and safety of concrete pavement compared to any other paving material. These differences are of the greatest economic importance. They exist because of the effect which jet aircraft and heavy wheel loads have upon airfield pavement and the effect which the pavement has upon such aircraft.

Savings accrue through use of concrete. These savings are gained through greater durability under today's severe operating conditions through longer service life, less maintenance, and less damage to costly aircraft.

The safety of millions of Americans depends upon the operational readiness not only of planes and men, but of the airfield pavement they must use (chart No. 12). The possible difference between pavement types is a small percentage of the total cost of an airbase; far less, in fact, than the cost of a single heavy bomber. Pavement cost is relative. The economy of a pavement is related to its performance, to the safety of crews and aircraft, and the effects of planes upon the pavement and the pavement upon the planes. Airfield pavement is a vital part of a defense team; the crew, the aircraft, and the airfield. The ability of all of these to function at any hour, any day, any season and any climate is essential.

Association testimony thus far has stressed the inherent economies of constructing all airfield paving with concrete. Wherever possible, we have discussed these matters in terms of dollars and cents. But there are some aspects of airfield operation impossible to measure precisely in terms of money (chart No. 13). In addition to economic considerations, there is the most important criteria of all in selection of pavement—the lives and safety of the pilots who must use it. According to official testimony presented before the last session of Congress, 66 percent of all major Air Force accidents occur in landing, takeoff, or taxiing.[20] In many of these accidents, runway quality or condition was the principal or a contributing-cause factor.

The facts now show how truly critical these areas are to aircraft operation and to pilot safety. During the past 5 years, the Air Force has recorded approximately 2,000 major accidents a year. In a typical year, these accidents result in about 800 fatalities to the finest young men in the United States.

CONCLUSION

So, in terms of lives lost and aircraft damaged, the so-called noncritical areas of our airfields are in fact very critical.

Damage to aircraft resulting from faulty paving can be given a money value. The lives of pilots are not measured in terms of dollars.

If the use of the highest quality airport paving could save even one of these lives—and the figures I have quoted indicated that the highest type paving can save a substantial number of them—no greater economy can be effected. Compromise is unthinkable.

[20] Flight Safety Testimony, by Brig. Gen. Joseph D. Caldara, Office of Inspector General, USAF, Subcommittee of the Committee on Appropriations, House of Representatives, 84th Cong., March 20, 1956.

I have attempted to show today by means of engineering fact, economic comparison, and the statements of eminently qualified authority, that on today's airfields all pavement is critical, and that the only economical pavement is the safest, most durable, most maintenance-free pavement—and that is concrete.

Thank you.

Mr. HÉBERT. Thank you very much.

I would just like to make two comments before we ask any questions. I am sure you didn't intend to leave the impression that the committee is in agreement with the present directive of the Air Force.

In your opening statement, or your opening pages, you indicated that the operation now is under the findings and the agreement into which the committee came in the 1954 hearings.

As a matter of fact, construction is not in accordance with that agreement or that understanding of the committee, which is the reason why we are back here today.

The committee at that time, under the chairmanship of Mr. Hess, came into agreement that the pavement was to be used in critical areas, and not in the noncritical areas, the Air Force without consulting the committee arbitrarily issued a directive, the noncritical areas were extended to become critical areas, thereby technically staying in agreement with the committee's finding but actually going beyond what the committee had agreed to.

Again, I am intrigued with the sentence that you have on page 4 at the top:

> This hearing is concerned with the need for concrete pavement in the so-called noncritical areas.

This hearing is concerned with the reason why the Air Force changed the agreement which was made, and is concerned as to why noncritical areas have been declared critical areas.

I merely make these comments in the interest of accuracy and to pinpoint exactly what we are trying to find out. I must compliment you on the statement. It is very adroit and very clear. If I had been on your side of the table, I would have been proud to have been able to write such a persuasive statement in your behalf.

I also call your attention to the dogmatic statement that the Kelly tests were failures. The testimony here has been abundant and multiple allegations have been made that the Kelly test was not a fair test on the flexible paving.

It was also testified that the construction of the flexible side of the track test went beyond—in its application to the actual test it went beyond the construction.

I just wanted to keep that in there so as to be accurate and know what we are talking about.

Mr. KENNEDY. May I make a comment?

Mr. HÉBERT. Yes.

Mr. KENNEDY. I am certainly in complete agreement with you that our statement did not intend to imply that the committee was in agreement to the application of concrete to the noncritical areas at the present time.

The page, on page 2—if I may just review it.

After a careful evaluation of all evidence presented—

and this refers to the 1954 hearings—

the committee ruled that the use of concrete in critical areas as defined by the Air Force and Navy was justified and should continue.

Now I am talking in this paragraph—and it is underscored—only about critical areas. And the committee at that time, I believe, Mr. Chairman, did agree that the concrete should be used in the critical areas. We comment on that editorially by saying:

The committee's judgment contributed lasting benefit to the Nation's defense.

In the later parts of the talk we go on to discuss noncritical areas. You are correct, sir, we do not intend to imply that this committee indicated that at that time concrete was to be used in noncritical areas.

The letter that is addressed to the Portland Cement Association, in the opening paragraph, referred to the reasons for the hearing which we have quoted, which indicates that it concerns the paving materials to be employed in the so-called critical areas of airfields. With my deepest respect, sir, it was merely quoting from the letter of the committee.

Mr. HÉBERT. The thing that I wanted to point up, Mr. Kennedy, is this: That at the time the committee came into agreement, there were certain areas called critical in which the committee was in complete accord with that statement and that position.

However, some time after the hearings and after the agreement had been reached and an accord had been reached, the Air Force arbitrarily circumvented the intent of the committee in its agreement by merely declaring so-called noncritical or a great many so-called noncritical areas as critical, which would, of course, technically bring them into the scope or the confines of the committee agreement. But actually, by merely declaring the noncritical areas as critical, they circumvented the intent of the committee. I am sure that in the reading of the letter there, you are again technically correct—but we are concerned with the noncritical areas that have been declared critical.

We are trying to find the reason for that, and the reason that in some instances the complaint has been made that practically the whole airfield in effect has been declared critical, to the exclusion of flexible paving.

Now, it would be just as simple for the Air Force, if it wanted to do so, to declare the roadway leading into the airport or the airbase as critical and stay within the confines of the agreement. I don't want to banter. I am sure you appreciate the fact that I do not want to banter. But I wanted to point up these things, to pinpoint them, to show our concern.

In reference to the Kelly test, as I indicated here, certainly it is an area that has not been resolved yet, because certain allegations have been made by the representatives of flexible paving to which the Air Force will be called upon to testify. That is not your concern. You are defending concrete.

Mr. KENNEDY. Yes, sir.

Mr. HÉBERT. As you probably should do. I compliment you on your presentation there.

Mr. KENNEDY. Thank you, sir.

Mr. HÉBERT. But at the same time, it is our job on this side of the table to get all the facts down, or as much of them as we can.

Mr. KENNEDY. We tried to avoid the area of disagreement between the committee and the Air Force and, after having commented upon the earlier decision, then our argument goes to the use of concrete in certain areas—the taxiways and the center of runways, which we now believe should be ruled by this committee to be critical, for the reasons that we have studied and included in our document.

Mr. HÉBERT. That is perfectly all right. A good offense is always your best defense.

Mr. KENNEDY. Thank you, sir.

Mr. HÉBERT. It is very, very, very enlightening to know how you charge in with an offense instead of a defense, which you had before. You want to take it all in now.

Mr. GAVIN. I think it is a very excellent statement.

Mr. HÉBERT. I agree.

Mr. GAVIN. Sound and informative. In fact, it is most impressive. I didn't participate too extensively in those 1954 hearings. However, I do feel that possibly what was noncritical back at that time may be critical today. How we could restrict the Air Force to critical and noncritical and who are not flying the planes and handling the management of these fields determine what is critical and what isn't critical, I don't know. I think they have to use their judgment to a certain extent. But the facts brought out in this statement here today as to the increased size and weight of these planes certainly—a field that may have been noncritical in 1954 may be critical today.

I just thought that this statement here covered the field as far as concrete was concerned. The gentleman did stay with concrete and kept his statement right within the purposes for which it was intended.

Mr. CUNNINGHAM. Mr. Chairman, I have a question to ask of you. Is this hearing today open to consideration of whether or not concrete is the best pavement in the critical areas as defined by this committee in 1954, or are we always open to select something else if it is proven to be better?

Mr. HÉBERT. We are always open, Mr. Cunningham, to accept a change.

Mr. CUNNINGHAM. This, then, is not confined to the mere question of expanding what was critical?

Mr. HÉBERT. No, sir. The reason the committee is here is because of the complaint of the flexible paving representatives, in what they consider as a violation of the original agreement entered into by the committee in 1954. Obviously, critical areas may be expanded at any time in the judgment of the Air Force.

Mr. CUNNINGHAM. The question was prompted, Mr. Chairman, by the witness' statement, or as I understood it his statement assumed the fact to be that there was no pavement suitable for the critical areas as they are defined in 1954 except concrete. I thought it was a pretty strong statement, and I wondered if we had closed the door.

Mr. HÉBERT. No; we have not closed the door.

Mr. CUNNINGHAM. All right.

Mr. HÉBERT. That was the reason for my observation.

Mr. CUNNINGHAM. I thought so.

Now I have one question, then, of the witness.

On page 23 you state:

In many of these accidents runway quality of condition was the principal or a contributing cause factor.

Were these accidents on the critical areas of runways that are covered by concrete or were some of them on areas covered by asphalt?

Mr. KENNEDY. Both, Mr. Cunningham.

Mr. CUNNINGHAM. What is the percentage of the accidents that were on concrete as compared with asphalt?

Mr. KENNEDY. We don't have access to those statistics. I rather doubt—the Air Force might be able to segregate them in that manner. We are not——

Mr. CUNNINGHAM. May I say this, Mr. Kennedy. From the way you presented your adroit statement—and I must say it was a Fielding Yost one, all right, in attack—I would infer and I think anyone would infer that the accidents you referred to on the runways would have occurred on concrete, since the taxiing and the takeoffs are all critical areas where the accidents would occur.

I am thinking of some years ago we had testimony before another committee of a wheel dropping through the pavement over at Offutt Air Force Base at Omaha. My understanding is that was concrete, is that correct?

Mr. KENNEDY. That is correct, sir.

Mr. CUNNINGHAM. And that cost the lives of 5 crewmen, who were burned to death. So you can have accidents with concrete just as well as anything else.

Mr. KENNEDY. Surely, the increasing loads that we have experienced since World War II make obsolete the pavements that were built in that period. As you know, in the area that you are discussing there are a number of airbases that were built during World War II and served the airplanes of that era. We have gone through an increase in the total load and the concentrated loads of a remarkable amount, and to observe these modern planes—the B–52 and the increased loads that will follow——

Mr. CUNNINGHAM. Then you didn't mean to state to the committee as I gathered from your statement that concrete is developed to the point today where it is suitable for all planes that may be developed in the future?

Mr. KENNEDY. Well——

Mr. CUNNINGHAM. You will have to strengthen your product as well as any other product.

Mr. KENNEDY. As far as existing runways are concerned, as the B–52 load may be increased another 25 percent, let us say, it will require certain strengthening of runways. Just as the World War II runways required beefing up by adding another overlay of concrete, which has been done extensively on our principal airbases.

Mr. CUNNINGHAM. Can you tell me what percentage in the mix is there of concrete on a good runway? How much is pure cement and how much is something else?

Mr. ANDERSON. There is a barrel and a half per cubic yard.

Mr. GAVIN. Aggregate.

Talk louder. I can't hear it.

Mr. COURTNEY. He said there is a barrel and a half per cubic yard.

Mr. ANDERSON. Six sacks per cubic yard. It would depend entirely, of course, on the thickness of the runway.

Mr. COURTNEY. You are talking about the percentage of mix now?

Mr. KENNEDY. That is right.

Mr. ANDERSON. It would be approximately 2½ percent.

Mr. CUNNINGHAM. Of——

Mr. ANDERSON. Cement per cubic yard. I divided 6 by 27.

Mr. CUNNINGHAM. Is that all the concrete that there would be in a cubic yard, 2½ percent?

Mr. ANDERSON. All the cement; yes, sir.

Mr. KENNEDY. The cement component of a cubic yard, Mr. Anderson is stating, amounts to 2½ percent of the cubic yard of concrete. That is about correct.

Mr. HESS. I don't think so.

Mr. COURTNEY. No.

Mr. HESS. It must be more than that. Because that would powder up.

Mr. ANDERSON. 22 percent, I'm sorry.

Mr. CUNNINGHAM. 22 percent.

Is that the best ratio that you have been able to find to give the strongest pavement, or would a greater percentage of pure cement make a stronger runway?

Mr. ANDERSON. There would have to be aggregate, Mr. Cunningham, in with it to make concrete. There are 6 sacks of cement, or 6 cubic feet out of 27 cubic feet, or cement, if I understood your question correctly.

Mr. CUNNINGHAM. My question is directed to this. If you reach a certain point of too much cement, does it weaken the runway?

Mr. ANDERSON. If you added what, sir?

Mr. CUNNINGHAM. In other words, if you made a pavement of pure cement, would it work?

Mr. HESS. Pure cement.

Mr. ANDERSON. Pure cement?

Mr. CUNNINGHAM. Pure cement.

Mr. ANDERSON. It wouldn't be satisfactory, sir.

Mr. CUNNINGHAM. Why not?

Mr. ANDERSON. On account of the shrinkage and internal stresses.

Mr. CUNNINGHAM. On account of the cost, too, wouldn't it?

Mr. ANDERSON. Well, that would be true; yes, sir.

Mr. CUNNINGHAM. I am thinking of safety.

Mr. ANDERSON. How is that?

Mr. CUNNINGHAM. I am thinking from the safety standpoint.

Mr. ANDERSON. Oh, in safety, the tendency with no aggregate would be one of greater smoothness or slickness than with the aggregate in it, sir.

Mr. CUNNINGHAM. How about safety?

Mr. ANDERSON. That is what I had in mind, was the surface texture of the pure cement—now I am taking your hypothetical basis of pure cement, which is never done, of course. That would have less skid resistance than 1 with only 6 sacks per yard.

Mr. CUNNINGHAM. When I worked as a tester in a cement factory, it was done.

Mr. ANDERSON. What is that, sir?

Mr. CUNNINGHAM. I say when I worked as a tester in a cement factory, it was done, at times.

Mr. KENNEDY. Well, in sampling cement, we are constantly making samples of cement paste which are allowed to harden.

Mr. CUNNINGHAM. Paddies?

Mr. KENNEDY. Yes. However, there is no use of cement paste as a structural material. The properties of cement for all structural purposes are much better when the aggregates are graded and added and mixed with water and hardened in that fashion.

Mr. CUNNINGHAM. Could you tell me what artificial stone—how much cement there is in that? That is artificial stone that is used in building today?

Mr. KENNEDY. With cement?

Mr. CUNNINGHAM. Artificial stone.

Mr. KENNEDY. Yes. You are asking the cement content?

Mr. CUNNINGHAM. Yes, do you know the cement content?

Mr. ANDERSON. Seven bags, I think.

Mr. KENNEDY. May I ask Mr. James Piper, vice president——

Mr. CUNNINGHAM. Wait. I will get it again.

That is all, Mr. Chairman.

Mr. FISHER. Mr. Kennedy, are you familiar with General Wilson's testimony, the Deputy Chief of the Corps of Engineers?

Mr. KENNEDY. It has been reported to me verbally. I have not had the opportunity of reading it, Mr. Fisher.

Mr. FISHER. I was wondering if you subscribe with his conclusion and views about both rigid and flexible and about the future?

Mr. KENNEDY. Well, I certainly subscribe to his views as stated to the committee, that there is nothing that can replace experience and practice as compared with laboratory testing.

I thought his statement with regard to concrete was a very wonderful statement. I am not familiar with what he did say about the flexible pavement. I thought he made a splendid witness before this committee.

As the dean of enginering at my school used to say, "When horsesense and engineering don't agree, use horsesense." And I think the general gave somewhat that type of an impression.

Mr. FISHER. Well, you are not familiar, then, with his comments about flexible?

Mr. KENNEDY. No, sir.

Mr. FISHER. I see.

Mr. KENNEDY. I think Mr. Ray heard that testimony, Mr. Fisher, and might be able to respond to you.

Mr. FISHER. I am just wondering if you agree in general with the conclusions he arrived at.

Mr. RAY. I believe we agree with what he said on both pavements with regard to design.

Mr. FISHER. I see.

Now just briefly, tell us how much more it costs to use rigid than it does flexible, in concrete pavement—percentagewise? Does it cost 10, 20, or 30 percent more?

Mr. KENNEDY. Well, you have had testimony before the committee which gave a range of costs. I believe the general stated to you that there are conditions where certain subbase situations make con-

crete the cheaper pavement, but by and large it is a more expensive pavement, on the basis of national averages.

Mr. FISHER. Assuming that you used the same subbase for both, currently what is the differential between the two?

Mr. KENNEDY. I would like Mr. Ray to answer.

Mr. RAY. It depends on many factors, sir. I mean local factors. In one area of the country——

Mr. FISHER. Well, let's kind of take an average in general.

Mr. RAY. The only average I could take probably is what has been given you. Because there is no such thing as an average. It varies as to individual bases, and maybe on a contract let later in the year, as contrasted to an earlier one that year. The two costs may change appreciably because of the factors that enter into the cost. You can't say, because it may cost a certain amount in New England and in Texas it may cost half that cost. In some parts of the country concrete may be cheaper than asphalt.

Mr. FISHER. Let's just take Texas and apply it there. About what is the differential in Texas?

Mr. RAY. Well, I can't give you the differential, because I can't give you cost on flexible. Concrete this year in Texas on 2 or 3 big jobs which have been awarded, I believe at Amarillo and Sheppard Air Force Base, and one at Bergstrom, has been the lowest price for concrete per cubic yard that we have had on any jobs for a number of years. It has been down to around $12 per cubic yard for concrete. Then if you know the thicknesses of their pavement—they run maybe 18 inches, and that would run maybe $5 a square yard for concrete on those real thick, heavy SAC bases. But they didn't take bids on flexible pavement for those same jobs, sir.

Mr. FISHER. O. K. That is all.

Mr. COURTNEY. Just 2 or 3 questions, Mr. Chairman.

Of course, Mr. Kennedy, your statement is based and your conclusions are based on one premise. That of course would be that the concrete pavement of which you spoke and are speaking was designed and was adequate to perform the job to which it was put.

Now what is the situation with respect to underdesigned concrete pavement? There is testimony here from General Wilson that of the failures that have occured in pavement on the bases which are now being made to serve the B–52 and the B–47, that I think five of them were concrete pavements. One is Lake Charles, and the others are Forbes, Dow, Castle, and Smoky Hill.

Now, with respect to the repair of that type of pavement in the case of failure—we have some 20-odd bases now that have been designed for the older aircraft or were designed for the older aircraft, with lesser load and lesser stresses, and lesser tire pressures—everything less than the present B–52 and B–47.

Now, what is the situation so far as concrete is concerned in the cost of souping up these pavements, if you please—just take the concrete pavements—to serve the newer loads? What about the expense of that?

Mr. KENNEDY. The Air Force has done a great deal of that kind of work during the last 5 years, what is commonly referred to as beefing up.

Mr. COURTNEY. Beefing.

Mr. KENNEDY. That consists of laying another layer of concrete on top of the earlier layer; and those vary in thicknesses a great deal. But they are heavy structures.

The cost for the new pavement will take a square yard price that is comparable with an original pavement. It might be somewhat less because there is not so much preparatory work to be done on the base. So you would expect that the cubic yard price that Mr. Ray has referred to would be comparable with the cubic yard price for concrete in place in an original pavement.

Mr. GAVIN. Mr. Counsel, I think that is a very important question. We have Colonel Conner and Colonel Alexander here.

What I would like to know from the Air Force is whether or not they are permitting any B–47's or B–52's to use bases that have not been reconstructed to take care of the heavy loads, that were designed for lighter planes.

Do you know of any bases where you are bringing these big ships that were designed for lighter equipment than in use today?

Colonel ALEXANDER. Yes sir, Mr. Gavin.

Mr. GAVIN. You ought to discontinue it, or you are going to have another accident.

Colonel ALEXANDER. Yes, sir.

Mr. GAVIN. How many fields would you say you are using that have this lighter construction that was designed for lighter planes that are now being used by B–47's and B–52's?

Colonel ALEXANDER. I couldn't tell you the total number, but they would be several.

Mr. GAVIN. What are you doing about it?

Colonel ALEXANDER. Our policy, Mr. Gavin, on the 100,000-pound pavement that will be overloaded is to observe that pavement very closely and not program strengthening or reconstruction, until it begins to show some indication of failure.

Mr. GAVIN. Well, supposing you had a bad crash there and there were a lot of lives lost. Would that prove to you, then, that you better do something about it?

Colonel ALEXANDER. The type of distress I am talking about is minor cracking, sir. Pavement as you recall the testimony of the Corps of Engineers is designed from empirical curves. There are many variables. Oftentimes, even though a pavement is designed for 100,000-pound loading, it will carry considerable more loading than that. So we don't feel justified in coming to the Congress and asking for money to strengthen these pavements until such a time as we know that they are showing distress.

Mr. GAVIN. How do you know what action the Congress would take if you did come and present your case and say that "The situation is rather critical and something may happen, and we think appropriations should be made to strengthen these pavements to meet the increased size of the planes and the loads."

Colonel ALEXANDER. We don't know, sir.

Mr. GAVIN. Then you better try and find out, because I think it is a very serious question, that you would be using pavements that were designed for lighter loads and are now coming along with the B–47 and B–52's. We ought to do something about it before we have some difficulties arise.

Colonel ALEXANDER. We will, sir. It will be programed.

Mr. KENNEDY. Mr. Hébert, may I ask Mr. Ray to comment on this point for a moment?

Mr. HÉBERT. Yes; certainly.

Mr. RAY. I believe there is some misunderstanding on these overloads. As General Wilson pointed out, concrete can take an overload over what it is designed for for quite a while before we get a serious failure.

Now you notice the reports in the Corps of Engineers and Air Force testimony, about cracking on these bases you have mentioned. In no case have they had to go in yet and replace and make any major repairs. We inspected three of those bases last summer. The cracks have been showing up since 1954 in one instance and yet that pavement is still in use by B–47's. The only repair was joint sealing of this crack to keep out water.

Mr. COURTNEY. You anticipated the question that I wanted to ask you, whether or not these failures that are spoken of here are sudden failures, between the time a plane takes off and it lands, or whether there is gradual and progressive deterioration.

Mr. RAY. It is gradual. Now, many of our bases are still using pavement built in World War II, designed for B–17's and B–29's, and they are still carrying B–47's and things, which are a terrific overload. They are showing some distress. But until that distress gets serious enough to show up to the point where it looks like it might need a repair, no repair is usually made.

Mr. COURTNEY. The point about it is simply this, that this distress is a gradual, progressive affair.

Mr. RAY. That is right, sir.

Mr. COURTNEY. And not something that is sudden.

Mr. RAY. It is gradual on concrete, and progressive.

Mr. COURTNEY. On concrete. That is what I am speaking of.

Mr. RAY. Yes, sir.

Mr. KENNEDY. Both of these terms "distress" and "failure" as used by witnesses are technical terms and aren't to be confused, at taking a look at these pavements and finding them in an unsightly, disorderly array. It doesn't mean that at all.

Mr. RAY. A crack——

Mr. COURTNEY. It does not mean that it is not operational.

Mr. KENNEDY. Not at all.

Mr. RAY. That is right.

Mr. COURTNEY. Simply because you say there is a failure or distress.

Mr. KENNEDY. Not at all.

Mr. COURTNEY. It means the pavement has cracked, but it is still operational.

Mr. KENNEDY. It means that the pavement should be strengthened.

Mr. COURTNEY. Strengthened.

Mr. KENNEDY. Yes.

Mr. COURTNEY. None of these failures are a sudden occurrence?

Mr. RAY. No. As you know, one crack in a pavement doesn't mean a failure as far as load-carrying ability goes.

Mr. COURTNEY. Now on this matter of concrete overlay of concrete pavements, how much proof is there of the ability to get a binder on the old pavement surface, with the application of a new overlay?

Mr. KENNEDY. Mr. Anderson, on my left, who is our chief consultant on the matter, prefers that these pavements be designed without a bond between the overlay and the initial pavement. There are two schools on the subject, and it does make some difference in the design calculations.

But our present recommendation is to consider them as acting as independent slabs, so that it is not necessary under those circumstances to secure a bond between the two pavements.

In another area of thin resurfacing, we are using a bonding process.

Mr. COURTNEY. Then the state of the art at the present time represents a difference of opinion as to how you should overlay.

Mr. KENNEDY. Yes, but in either case there is a well accepted design method——

Mr. COURTNEY. Whichever method you follow.

Mr. KENNEDY. Yes.

Mr. COURTNEY. Is that it?

Mr. ANDERSON. Whichever method is used.

Mr. RAY. It depends on economy, which type of method is used normally.

Mr. COURTNEY. Well, I have in mind the overlay at Selfridge Field, which is an important base.

Mr. ANDERSON. That is what we call a thin bonded overlay, and the restoration of surface and not of beefing up.

Mr. COURTNEY. In other words, the failure or the distress, if you please, at Selfridge was a surface failure?

Mr. ANDERSON. That is correct, sir.

Mr. COURTNEY. Spalling and breaking of the surface.

Mr. ANDERSON. Of the surface.

Mr. COURTNEY. That was done, as I understand it, by roughing the surface and etching it with acid and then applying your overlay?

Mr. ANDERSON. That is correct.

Mr. COURTNEY. And the cost of that was something like $3.49 a square yard; is that right?

Mr. ANDERSON. In that initial contract, that is correct, sir. That was the first contract let to that type of work.

Mr. COURTNEY. How about the second contract?

Mr. ANDERSON. That hasn't been let yet.

Mr. COURTNEY. Has not been let?

Mr. ANDERSON. Yes.

Mr. COURTNEY. So you have only one price experience.

Mr. ANDERSON. The other experiments that have been in that type of pavement construction have been done under what I call a day-labor method on account of the newness of some of the features in the construction. You mentioned the acid, for example.

Mr. COURTNEY. Yes.

Mr. ANDERSON. A lot of people were scared of the acid. At a cost of 25 cents a square yard they started with, to etch that surface with acid. Now, we reduced it to somewhere around 5 or 6 cents.

Mr. COURTNEY. To 5 or 6 cents.

Mr. ANDERSON. Yes; that is where we are on the etching process.

Mr. KENNEDY. I think this goes into another area that the committee has been concerned with in its previous witnesses, and that is the fact that on this Selfridge Field job the association was called into consultation by the Air Force. Mr. Anderson, I am sure, con-

tributed greatly from his years of experience in this field, and our Mr. Westall was resident on the job. We enjoyed our engineering relationship with the corps and the Air Force in pioneer work of that kind. Selfridge Field, of course, is a World War I field, and the large apron area, I think, was built during World War II or before.

Mr. ANDERSON. During World War II, part of the apron area, and part of the area covered, was an old runway built some thirty-odd years ago.

Mr. KENNEDY. Yes. That is a very interesting point. That 30-year-old runway was covered with a thin resurfacing.

Mr. COURTNEY. Now, of course—has that reached the point where you can say you have perfected a design and a method which will be serviceable for a long period of time?

Mr. KENNEDY. No.

Mr. COURTNEY. This is an experimental——

Mr. KENNEDY. It is experimental. But Mr. Anderson has brought this art forward very rapidly in the last 3 or 4 years, particularly on some paving in Iowa and in Pennsylvania.

Mr. GAVIN. What part of Iowa?

Mr. ANDERSON. Burlington.

Mr. KENNEDY. Burlington, Iowa.

Mr. CUNNINGHAM. That is not in Iowa. That is in the Mississippi River.

Mr. COURTNEY. I have another question. I presume it is Mr. Anderson. That is with respect to the other type of beefing up, the heavier slab where you are not concerned with the bind. Do you have some experience and some cost data on that?

Mr. ANDERSON. We have long experience from actual projects in service and from——

Mr. COURTNEY. I am thinking of airfields now.

Mr. ANDERSON. Yes, sir.

Mr. COURTNEY. Military airfields.

Mr. ANDERSON. That is right. We also have the benefit of research work that has been conducted by the Corps of Engineers laboratory at Cincinnati.

Mr. COURTNEY. Now, this, of course, is for structural additions, isn't that right—for strength?

Mr. ANDERSON. That would be for strength.

Mr. COURTNEY. For strength.

Mr. ANDERSON. May I elucidate just a little bit, Mr. Courtney?

Mr. COURTNEY. Yes, sir.

Mr. ANDERSON. Mr. Kennedy said I preferred not to bond in that particular case. We have formula or methods of design, where that new beefing up is bonded or unbonded. Is that clear?

Mr. COURTNEY. Yes, sir.

Mr. ANDERSON. In other words, the thickness surface. We have this matter of economy and matter of the condition of the old pavement involved in each case.

Mr. COURTNEY. As to which method is the more economical?

Mr. ANDERSON. That is correct, sir.

Mr. KENNEDY. Mr. Ray would like to add something.

Mr. RAY. I might point out, on that, that during World War II, three very large airfields which had been designed as training bases

were up to a bomber criteria, and they were resurfaced with concrete during World War II to carry B–29's and so forth, and those are still in service with their second surface. One is at Fort Wayne, Ind., one at Louisville, and one at Alexandria, La.

Mr. COURTNEY. Yes. What design method was followed?

Mr. RAY. That was the unbonded resurfacing. They came in with a second layer.

Mr. COURTNEY. They came in with a second layer?

Mr. RAY. That means the original pavement was about 6 inches and the overlay was about 6 inches, in that vicinity. They are doing very well today.

Mr. KENNEDY. That is standard, accepted engineering practice. That is not in the experimental period at all.

Mr. COURTNEY. Then, let me ask you this question. I take it from what you say now—correct me if I am wrong—the old method of overlay is an accepted practice. The method at Selfridge is still in the experimental stage; is that correct?

Mr. ANDERSON. That is correct.

Mr. KENNEDY. Yes.

Mr. COURTNEY. Now, in the case of the overlay, without bond or with bond, as the case may be, what experience have you had on costs on that?

Mr. ANDERSON. Well, as Mr. Kennedy pointed out, the costs involved are generally those of the cubic-yard costs that would prevail at that location.

Mr. COURTNEY. Yes.

Mr. ANDERSON. For the surfacing.

Mr. COURTNEY. For new paving.

Mr. ANDERSON. For the new paving on top; that is, the top layer.

Mr. KENNEDY. Yes.

Mr. COURTNEY. Would the costs be the same as new paving of the equivalent thickness?

Mr. ANDERSON. Thickness; that would be correct, sir.

Mr. RAY. Less.

Mr. ANDERSON. Probably a little bit less because of one thing, and that is because you have the old surface to operate on——

Mr. COURTNEY. You don't have to worry about your subgrade; is that it?

Mr. ANDERSON. That is right.

Mr. COURTNEY. Is that the difference?

Mr. ANDERSON. Yes; that is the difference.

Mr. KENNEDY. That is the difference.

Mr. COURTNEY. Mr. Chairman, I think that is all.

Mr. HÉBERT. I have another question I want to ask Mr. Kennedy. To what extent did you or your representatives participate in the Kelly test?

Mr. KENNEDY. We were not present at the Kelly test.

Mr. ANDERSON. We have periodical inspection of the tests.

Mr. KENNEDY. May I ask Mr. Ray to comment.

Mr. HÉBERT. Yes.

Mr. RAY. I may say we didn't participate in any way in the setting of the test or the conduct of the test. After we were advised that such a test was being held we made periodic visits; I believe altogether maybe 5 times. We went down and spent a couple of hours on the job

watching the testing procedure and observing the pavements. We weren't there during the construction of the concrete and we weren't there at the time the test ended, but we did observe what was going on.

Mr. HÉBERT. Did you have any suggestions or any participation in the designing of the concrete for the test?

Mr. RAY. No, sir. We have worked with the Corps of Engineers, with their design people at the rigid-pavement laboratory, and we are familiar with their design procedures. We have great confidence in their design methods. They checked very well with our own recommendations for designs. So we had no question.

Mr. HÉBERT. Before the actual construction at Kelly took place, did you confer or participate with the engineers as to the type of design?

Mr. RAY. No, sir. They told us that there was a test and it would be designed by their latest criteria, but we didn't question—we had no questions on it. We accepted their design criteria as being adequate. We weren't asked to contribute.

Mr. HÉBERT. You merely went there on several occasions as observers?

Mr. RAY. As observers, yes, sir.

Mr. HÉBERT. I think that is all, Mr. Courtney.

Thank you, gentlemen, very much.

Mr. GAVIN. May I ask a question? What do you think of the Kelly test?

Mr. KENNEDY. Well, as Mr. Hébert very properly pointed out, you have had a great deal of testimony before the committee. The question has been raised as to the design of the asphalt surface involved. I think that we are hardly in a position to give you a sound opinion on that Kelly test.

Mr. GAVIN. Well, you heard the testimony the other day about the accelerated tests, where they were back and forth, which wouldn't be comparable to the method in which a field would be used. There is one feature of it. What do you think about that? That didn't impress me as being the right approach to a test. It wouldn't be comparable to a test of a plane on a field. Here they take the Kelly test and go over it continuously, which is not indicative of the operation of a plane on a field. What do you think of that feature of it?

Mr. KENNEDY. Well, in the engineering science the accelerated test is quite a common procedure. Just now under congressional direction, under the Roads Committee, you are conducting an accelerated test to both types of pavements at what we call the national test road.

Mr. GAVIN. That wouldn't be comparable to an airfield, a highway. Because you do have acceleration on a highway, but you don't have it on an airbase. Why wouldn't your engineers design that test that would be comparable to the conditions that were going to take place on an airbase and not on a highway? You haven't planes going over an airbase the same as you have over the Pennsylvania turnpike. I just wondered what you thought—whether that was the right approach or not.

Mr. KENNEDY. I think if you will permit me, Mr. Gavin, I am going to ask Mr. Ray to make a few comments on that situation?

Mr. GAVIN. All right; make them.

Mr. RAY. Accelerated traffic tests have been an accepted method of evaluating designs——

Mr. GAVIN. I don't care whether they are accepted or not. They are not comparable. That is what I am getting at.

Mr. RAY. Sir, if we didn't do that, we would have to wait 25 years or something to find out how this performance was going to stack up. So an accelerated test is a severe test.

Mr. GAVIN. Yes.

Mr. RAY. But it is severe on both pavements. It is just as severe on the concrete, to accelerate that traffic in 2 months, as it is on the other type pavement. Also concrete normally in a 25-year life continues to gain strength and we lose that in the accelerated test.

But we feel an accelerated test is one method of evaluating design methods. It has been used for quite a while by the Corps of Engineers and by many other pavement-building agencies. We feel it is a fair method of evaluating pavements.

Mr. GAVIN. Well, I thought that the gentleman said the other day that in his opinion it was not the true test to give to both rigid and flexible—the accelerated test. Whether or not it is fair, I don't know. It doesn't appear to me as though it would be fair. The acceleration that you get on a highway is not the acceleration you get on an airbase. You certainly wouldn't be running B–52's up and down and up and down.

Mr. RAY. I don't believe that is what Mr. Kennedy contended. He was just stating that has been a method of evaluating highway designs for many years. They do the same thing on a highway test. They put traffic that may normally occur in 20 years, in 1 year, by running them closer together.

Mr. KENNEDY. Let me call your attention to another item that is not parallel to an air test.

In an accelerated highway test, where in 1 year we pass over the road the number of vehicles that may occur in 20 years, we lose the factor of weather entirely, and weathering influences affect all pavement. So to that extent accelerated tests aren't exact reproductions of full-scale longevity testing.

Mr. GAVIN. Because of weather?

Mr. KENNEDY. Nevertheless, Mr. Gavin, the accelerated test properly done is an accepted engineering procedure.

In the case of the Kelly test, I think that our own observation of the work of the Corps of Engineers indicates that that would be considered valid in engineering circles.

Mr. GAVIN. Well, now, in view of the fact, Mr. Chairman, there is some question about the test. I think we ought to hear from the United States Corps of Engineers.

Mr. HESS. Yes.

Mr. GAVIN. What they intend to do in the way of further study and what further tests they are going to develop, so we can get some idea.

Mr. HÉBERT. The comittee plans to hear the engineers again, Mr. Gavin.

Mr. GAVIN. You do?

Mr. HÉBERT. Thank you, gentlemen, very much.

Mr. KENNEDY. Thank you.

Mr. COURTNEY. Mr. Chairman, I have to say to the witnesses that we will reproduce as many of your exhibits as the Government Printing Office will print.

Mr. KENNEDY. That is correct.

Mr. COURTNEY. There are some restrictions on that. I am not sure all of them can be reproduced. But if there is any omission, it will be the judgment of the Printing Office.

Mr. KENNEDY. All right.

May I thank the committee for their courtesy to us.

Mr. HÉBERT. Thank you for coming in, Mr. Kennedy.

The next witness, Mr. Courtney.

Mr. COURTNEY. May we have the Bituminous Concrete Association here?

The contractors association in the order in which you are going to talk.

Mr. HÉBERT. The committee will be in order, please.

Mr. COURTNEY. Mr. Chairman, we have Mr. Sheldon G. Hayes, who is president of the National Bituminous Concrete Association here, along with several representatives of that association.

Mr. Hayes is here, and has a prepared statement, Mr. Chairman.

Mr. HÉBERT. Mr. Hayes, you may proceed.

TESTIMONY OF SHELDON G. HAYES, PRESIDENT, AND H. K. GRIFFITH, EXECUTIVE DIRECTOR, NATIONAL BITUMINOUS CONCRETE ASSOCIATION

Mr. HAYES. Mr. Chairman and members of the committee, my name is Sheldon G. Hayes, and I am president of the National Bituminous Concrete Association, with offices here in Washington.

I am also the president of my own paving company in Detroit, and have constructed flexible pavements of asphaltic concrete for over 30 years.

First, let me express my thanks for the invitation to come before the committee and acquaint the subcommittee with our members' experience in asphaltic concrete construction for airfields.

The National Bituminous Concrete Association is a national, nonprofit organization, voluntarily supported by its 400 members and 90 percent of whom are contractors. They have no commitments to use any particular product, material, or technique, and many of them built both asphaltic concrete and portland cement pavements.

Their one purpose, to build the best and most durable pavements at the lowest cost, does not allow them to be committed to any industry or construction method.

The association is in no way engaged in the manufacture, pricing, or sale of asphalt or aggregates.

It supports and coordinates the work of its members and contractors in every State.

The association disseminates information about asphalt concrete and upgrades paving standards, so the public benefits from better and more economically built pavements.

Asphalt concrete pavements have demonstrated their superior serviceability, durability, and economy for over 25 years at all types of military and civil airports throughout the world.

There are over 1,500 experienced contractors in the United States who have the most modern construction equipment and skilled per-

sonnel. They're equipped to build whatever type of heavy-duty modern airport pavement the Department of Defense specifies.

These men are in constant touch with the latest techniques and machinery all over the country. As a result, they incorporate the latest advances into their work.

We do not presume to question the Armed Forces' needs in providing maximum security for our Nation. We feel, however, that this need can be more economically provided. The 1954 criteria as established by this committee and agreed to by the Air Force, for military airfield pavement, is the proper one to abide by. It is sound both from engineering and economy standpoints.

As their president, I can express the members' feeling by saying that they ask for no preferential treatment or special dispensation—rather, for the opportunity to bid competitively on public works projects. By not arbitrarily excluding them from future projects, the Government will be able to realize considerable savings—often as much as 50 percent in its airport pavement construction.

A number of my associates, Messers, John W. Kelly, H. S. Kerr, A. J. Kavanaugh, are not present today but we had their paper, and would like to get permission to have it entered in the record, and H. K. Griffith and Byron Shumacher, who are present. These men have spent most of their lives in paving both with asphalt concrete and portland cement concrete. They have just visited seven SAC bases: Loring, Dow, Pinecastle, Homestead, Lockbourne, Altus, and Tinker, as well as many other airfields. They will give you eyewitness accounts of how asphalt concrete pavements are standing up.

Mr. HÉBERT. Do you care to have any of these gentlemen testify now, Mr. Hayes?

Mr. HAYES. Well——

Mr. COURTNEY. Mr. Griffith.

Mr. HAYES. I will turn it over to Mr. Griffith, Mr. Chairman.

Mr. HÉBERT. Mr. Griffith.

Mr. GRIFFITH. Shall I proceed?

Mr. COURTNEY. Yes.

Mr. Chairman, Mr. Griffith has a prepared statement.

Mr. HÉBERT. Proceed, Mr. Griffith.

Mr. GRIFFITH. Mr. Chairman, first, let me say that I, too, appreciate the opportunity of appearing before this committee, and assisting with developing information the committee may find of interest in considering the problem at hand.

We also appreciate the courtesies extended to us by the committee staff.

I have a prepared statement that I should like to enter into the record, with two corrections.

On page 5, the first line of the second paragraph, where it says "as an example, today's wheel load," I would like that changed to "gear load."

Mr. COURTNEY. Gear?

Mr. GRIFFITH. Yes, sir.

Mr. HÉBERT. "Gear" instead of "wheel."

And on page 14, at the very end of the statement, I would like to make the following correction.

These are shown on pages M 1–1 to M 1–10, of the NBCA's presentation, titled "Facts Show Asphalt Can Take It."

Now in your possession——

Mr. FOGO. You are adding that?

Mr. GRIFFITH. Yes, sir.

Mr. BROOKS. What page is that?

Mr. FOGO. That is being added.

Mr. COURTNEY. That is being added as a last sentence, Mr. Chairman.

Now, Mr. Chairman, in addition to the statement, there is another document which the association has distributed to the members. All of them have the title "Facts Show Asphalt Can Take It." That, Mr. Griffith, is part of of your presentation, and you desire to have it made a part of the record?

Mr. GRIFFITH. Correct, sir.

Mr. COURTNEY. With the same reservations, Mr. Griffith, as to the pictures and designs. So many of them as the Printing Office can reproduce will be reproduced and the others we will just have to live with.

Mr. GRIFFITH. We understand, sir.

And that document——

Mr. COURTNEY. Or live without, I should say.

Mr. GRIFFITH. That document, which you have, is the first phase of three of our presentations.

Mr. COURTNEY. Very good.

Mr. GRIFFITH. And it well documents our case.

(The volume referred to is as follows:)

FACTS SHOW ASPHALT CAN TAKE IT

(National Bituminous Concrete Association, Inc., Washington, D. C., June 1957)

DEFINITION OF PAVEMENT TYPES

There are two principal types of pavement in use today for all airports and highway uses. In engineering terminology, they are referred to as flexible and rigid pavements.

Flexible pavements consist of one or more layers of aggregate varying in thickness placed on an approved subgrade foundation. Covering this is a bituminous layer composed of two or more courses—each a few inches in thickness. In 98 percent of the cases this material is asphalt concrete. Other types of bituminous material may be used for this covering layer.

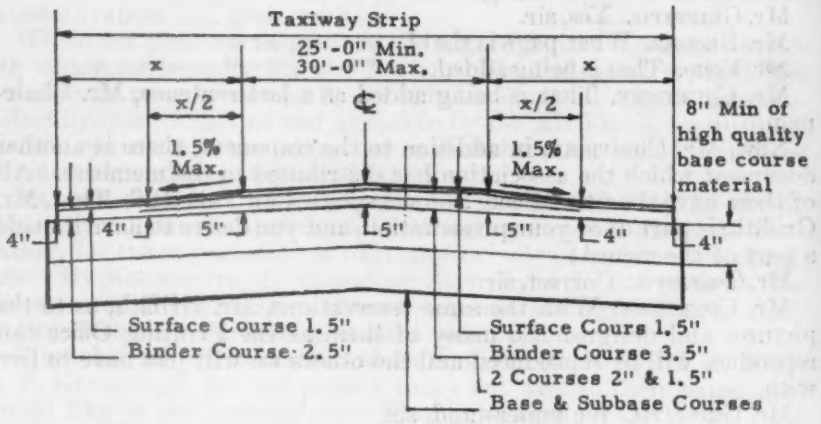
Rigid pavements are of portland cement concrete construction. The concrete slab is supported on subsoil over which there may be a subbase of aggregate (recently added to specifications) or other granular material. It may or may not contain steel reinforcement with joints at appropriate intervals to provide for expansion and contraction and/or to control cracking.

In this presentation:

Flexible pavements are referred to as asphalt concrete.

Rigid pavements are referred to as portland cement concrete.

Typical cross sections of each type are shown on the following page.



TYPICAL FLEXIBLE PAVEMENT

TYPICAL RIGID PAVEMENT

TYPICAL PAVEMENT SECTIONS FOR CHANNELIZED TRAFFIC AREAS

Corps of Engineers Interim Criteria May 3, 1955

ASPHALT PAVEMENTS ARE SERVICEABLE, STRONG, AND DURABLE

Approximately half of our Air Force pavements within the continental United States and overseas are of asphalt concrete construction. They're suited to every traffic condition because of their durability, serviceability, and economy.

Subjected to much heavier loads than they were designed for, millions of square yards of asphalt concrete pavement are serving all over the world. They've been built for much less than any other type of pavement would have cost.

Every year countless square miles of pavements are resurfaced and strengthened with asphalt concrete. Were it not for the ease with which asphalt can strengthen and resurface pavements, our maintenance costs on military airfields would be so much greater than they are now. Portland cement concrete pavements which have spalled or failed would have to be either completely removed and replaced or overlaid with another pavement at great expense. When a new layer of portland cement concrete is placed over the old surface, it frequently is much thicker than the pavement on which it rests.

Not so with asphalt concrete. Usually, only a few inches added to most any pavement which has suitable construction beneath it, produce a durable, smooth surface.

The finished job is comparable to a new pavement in all respects. Many a runway has been strengthened and made serviceable by this method, at a small fraction of what a new pavement would cost.

This outstanding asphalt concrete advantage explains its wide usage in airport and highway work. Properly designed, asphalt concrete pavements have a long life and require little maintenance.

At the Hess hearings it was conclusively established that asphalt concrete pavements were serving under conditions far more taxing than they were designed for. Only the question of an unfavorable price differential was considered at the time.

In some instances, where the two types of pavements have been placed side by side and subjected to jet blast under actual operating conditions for many years, as they have been at Sherman Field (Pensacola Naval Air Training Station), there has been practically no difference in performance between either type of material. However, the asphalt pavement was built at much less cost.

ASPHALT HAS BEEN SERVING FOR OVER 25 YEARS—O. K.'D BY MILITARY, ENGINEERING, AND CIVILIAN USERS

General Washbourne clearly stated in a discussion with Congressman Charles P. Nelson, during the Hess hearings, that asphalt concrete pavements could stand up under military operation.

"And if they are designed to take care of that (any) airplane, each one of them is suitable, except for blast damage and fuel spillage."

General Washbourne said: "As far as I know the flexible (asphalt concrete) pavement and the rigid (portland cement concrete) pavement can both be designed to carry the weight, whatever it turns out to be."

General Washbourne furnished a breakdown of the areas at 88 Air Force bases within the continental United States. On runways there were:

21,973,000 square yards of asphalt concrete.
14,528,000 square yards of portland cement concrete.

Asphalt led by 3 to 2 over portland cement concrete

How engineers and airport officials judge asphalt paving can be seen by their overwhelming preference for this material in their choice of asphalt paving for 7 out of 10 of the United States major airports:

Chicago's Midway, New York's LaGuardia, Washington's National, Los Angeles' International, Atlanta's Municipal, Miami's International, and Albuquerque's airports are surfaced with asphalt. The engineers and public-works officials preferred asphalt pavements for heavy aircraft traffic. Recently, New Orleans' Moisant Airport was resurfaced with asphalt.

Chicago's asphalt-surfaced Midway, the busiest airport in the United States, has been used by 67 million passengers during its 28 years of operation. Excluding local traffic, the Civil Aeronautics Administration's figures listed 366,079 flights during 1956. Two of Midway's taxiways are slated for strengthening this year by overlaying with 2½ inches of asphalt hot-mix which will modernize the runways for the heavier DC–7's. Asphalt's flexibility is especially important to the fast-changing aircraft industry.

The wide usage and satisfactory service of asphalt attest to its suitability for military paving. The degree to which asphalt has been used by the Air Force was brought out by General Washbourne at the Pavements Maintenance Conference held in May 1956 at Colorado Springs:

"The yardage laid by the Air Force during its expansion program from 1950 to 1955 was approximately 50–50: that is, half rigid (portland cement concrete) and half flexible (asphalt concrete)."

Mr. Paul T. Sutton, pavements engineer of the Air Proving Ground Command of the Air Force, gave reasons for his preference for asphalt concrete for military airfield pavements. He discussed both types of concrete at the Pavements Maintenance Conference. Here are the main points he made:

Asphalt concrete can withstand jet blast and fuel spillage if proper materials and good construction are used.

Portland cement pavements have a continuous joint (maintenance) problem and are very costly to repair in case of failure.

The uncertainty of future aircraft weights and wheel loads makes asphalt concrete desirable for pavements as they can be economically and rapidly strengthened.

Portland cement concrete slabs tend to warp when they are thick, from the internal stresses resulting from temperature differences between top and bottom surfaces. If portland cement concrete is used for channelized traffic in some areas, these slabs will be more than 2 feet thick. Warping of the portland cement concrete may produce an uneven surface and crack the slab.

Mr. Sutton's statements are repeated for their full engineering significance:

"* * * I am very well satisfied with this arrangement. As far as I have ever seen, asphalt concrete pavements, subjected to moving traffic only, have held up excellently except in a few cases of improper design or where proper control was not exercised during construction."

"The problem, inherent in rigid-type pavements of joint maintenance is eliminated as is the prospect of facing what could be *a very costly project in cases of failure * * * (of) the extremely thick slabs (portland cement concrete) now required for channelized traffic.* If wheel loads are increased still further in the future, either from inservice loading or aircraft design, the flexible (asphalt concrete) type pavement *will lend itself more readily to strengthening to meet these additional loads. Then, too, they would be more economical to repair in cases of pavement failure due to overloading.*"

"If it is decided to construct runways using a rigid (portland cement concrete) pavement, certain localities, having soils with a low "k" value and aggregates producing a low flexural strength concrete, will have pavement thicknesses exceeding 2 feet in the channelized areas, assuming that present design methods are followed."

Mr. Sutton continued: "These extremely thick slabs are going to present problems due to internal stresses set up *from warping caused by temperature differential of the top and bottom surfaces.* To eliminate this problem, as well as to effect a possible economy in construction, the traditional concept of rigid (portland cement concrete) pavements as a slab whose strength is increased by adding to its thickness might well be discarded in favor of reinforced or prestressed sections in the channelized areas." [Editor's italic.]

James T. Pyle, Acting Administrator of the Civil Aeronautics Administration, accurately summed up the pavement situation in regard to commercial jets at the Jet Age Conference of the Spokane wing of the Air Force Association at Spokane, Wash., in September 1956.

"Every airport manager is interested in the effect of the heavy jets on his runway paving and the paving of his taxiways and runup pads. It may be necessary to add to the paving thickness at some airports, particularly if the jet transports are heavily loaded. However, the wheels of the new aircraft are widely spaced so that they spread the weight over large areas of pavement and the runway problem, from a load-bearing standpoint, does not appear to present us with any immediate crisis.

"The effect of jet blast and spilled fuel on paving is something which we are investigating carefully since we are deeply concerned with both new and existing construction. From what we have learned to date, it does not appear that either the blast or an occasional bit of spillage is going to do any great amount of damage."

Asphalt pavements on both military and civilian airports have withstood every type of service condition. Some examples, as observed by engineers and contractors in the paving industry are listed below:

From H. S. Kerr, vice president, H. B. Zachry Co. of San Antonio, Tex.:

"We have built asphalt concrete (flexible) pavements that are meeting the requirements of B–52, B–47, tankers and fighter aircraft at Bergstrom AFB and Kelly AFB. These pavements have been standing up under actual traffic and have done the job required of them.

"Our recent inspection of the asphalt concrete pavement placed at Bergstrom AFB, Tex., in 1952–53 reveals that the pavement is in perfect condition. The runways have given 4 years of service to practically all types of military aircraft, most frequently to the F–84F and 84G jetplanes. The tire pressure on the F–84F is 300 pounds per square inch and is as high a pressure as is used on the larger aircraft. The KB–29 tankers, the B–47, and B–36 aircraft have also used this field.

"There is some evidence of fuel-spillage on the asphalt concrete, but these areas show no sign of deterioration or distress from it.

"There is no indication of any surface maintenance having been required during the 4 years Bergstrom AFB had been in service."

From Mr. E. J. Woodward, Jr., chief engineer of industrial asphalt of Los Angeles, Calif.:

"Runways were resurfaced and new runways and taxiways were constructed by Seeley-Miller Contracting Co. in 1951 and 1952 and at the El Toro Marine Base in Santa Ana, Calif. Over 300,000 tons of asphalt were used on this job.

"I personally worked on the mix design, testing and laying down on this operation * * * This job has been very successful and was carried out under rigid Navy inspection.

"Air traffic on this field has increased greatly in the last few years, and the pavement is still giving excellent results without rutting. Large cargo planes land and take off minutes apart, 24 hours a day from this field. The Air Force landed one of its largest cargo planes on it the other day to pick up equipment and similar types of planes are landing each day. This field has taken a great deal of punishment and still the upkeep is relatively small. I visited this field regularly and can truthfully say that it is doing an excellent job * * *

"Civilian airfields also use a great deal of asphalt pavement in this area. Most of the fields have about 90 percent of the total landing area covered by asphalt paving material."

From H. K. Griffith, executive director of the National Bituminous Concrete Association, after inspecting three naval airfields at the Pensacola Naval Air Training Station, Pensacola, Fla., on April 11, 1957:

"All three fields have been built of light duty construction and have been subjected to extreme use, far beyond what they were designed for. In all cases they have withstood a wide variety of traffic with very little maintenance.

"Sherman Field, Naval Air Training Station, Pensacola, Fla., is a jet field designed for 50,000 pound wheel loads with 250 pounds per square inch tire pressure. It is being used by jet trainers 40 percent of the time and by practically every other type of aircraft.

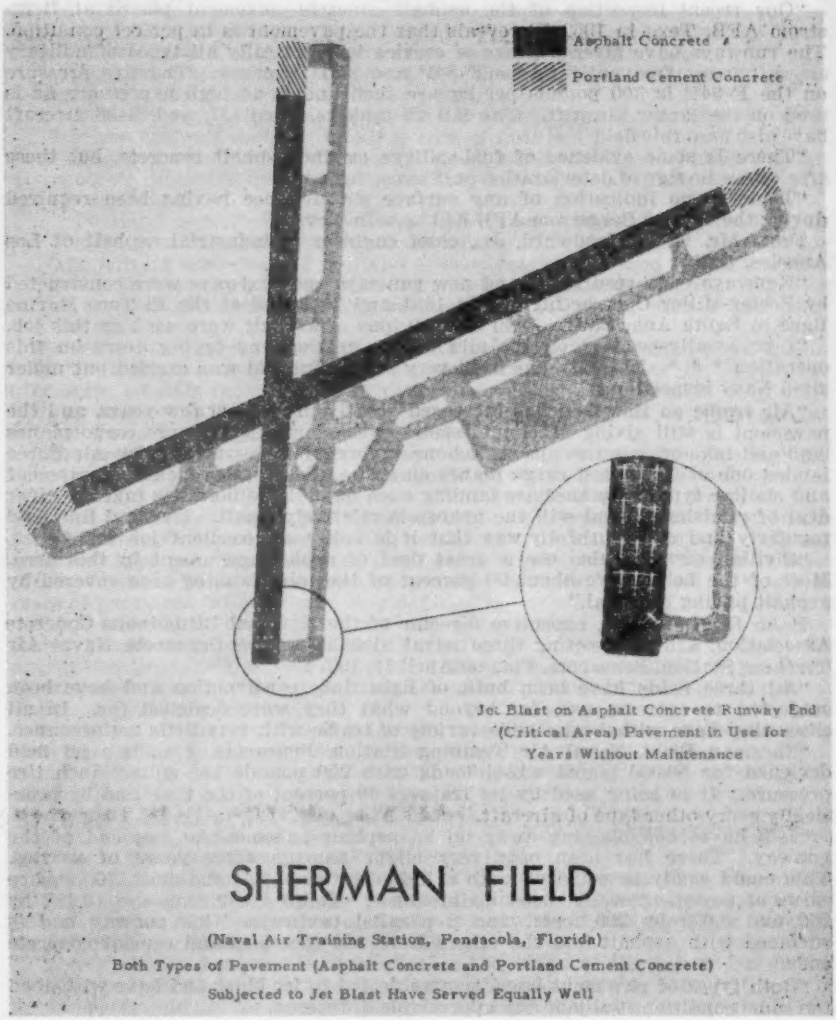
"Jets have been blasting away on an asphalt pavement at one end of the runway. There has been only very slight damage after years of service. This could easily be repaired with a light-duty seal. At the most, 100 square yards of pavement would need maintenance. There are 2 runways (6,137 by 200 and 8,000 by 200 feet), and 2 parallel taxiways. One runway end is surfaced with asphalt and the others have 500 foot portland cement concrete ends.

"Both types of pavement have been subjected to jet blast and have withstood the same conditions without any appreciable difference.

"The base was constructed on 12-inch compacted select soil consisting of 70 percent shell and 30 percent sand. Additional construction consisted of a 2-inch asphalt base, covered by 1½ inches of asphalt concrete for the wearing surface. The material used was three-fourths inch blast furnace slag and native sand. The job was started in September 1951 and completed in December 1953, and has been in use ever since. A seal was applied September 1956."

The runways at Sherman Field, Naval Air Training Station, Pensacola, Fla., are shown on the following page. At one runway end, where the surfacing is asphalt concrete, jets have been blasting away on the surface. Only negligible damage has resulted, as has been pointed out.

Asphalt concrete has served as well as portland cement concrete in this critically designated area.


Asphalt Concrete
Portland Cement Concrete
Jet Blast on Asphalt Concrete Runway End
(Critical Area) Pavement in Use for
Years Without Maintenance
SHERMAN FIELD
(Naval Air Training Station, Pensacola, Florida)
Both Types of Pavement (Asphalt Concrete and Portland Cement Concrete)
Subjected to Jet Blast Have Served Equally Well

From H. K. Griffith's inspection of—

"Whiting North Field, Naval Air Training Station, Pensacola, Fla.—This all-asphalt field has been in service since 1943 without any maintenance, as far as can be determined. In 1953 the pavements were surfaced with a sand-seal coat and are still in excellent condition. Jets used the field extensively between 1951 to 1952. There are 2 asphalt concrete runways (6,000 by 300 feet) and 2 taxiways. The original construction consisted of a 6-inch sand-asphalt base mixed in place. This was covered with a 1½-inch hot-mix sand-asphalt layer and a 2-inch hot-mix asphalt-concrete surface in 1945. No portland cement concrete has been used on this field at all.

"South Field, Naval Air Training Station, Pensacola, Fla.—Was built of the same construction and about the same time as North Field. In 1947 a 1½-inch hot-mix, sand-asphalt surface was applied. This was more of a patch job than an actual resurfacing. This was followed by a 1½-inch hot mix, sand-asphalt leveling course, above which is a 1½-inch asphalt-concrete wearing course. Jets and P–28 training planes use this field occasionally. This field has withstood continuous service and has had very little maintenance since it was built."

And here are more asphalt-concrete fields which are standing up—

Sophly Field, Naval Air Training Station, Pensacola, Fla.—Was surfaced with 1½ inches of asphalt-concrete in 1953. There has been no maintenance on this field since, although an estimated $5,000 could be spent on repairs so as to restore the pavements to first-class condition. Damages to pavements resulted from jets warming up. The damage is small (500 square yards) comprising only 3 percent of the entire field's 18,000 square yards. The maximum depth of the damaged areas is 1 inch. The field has been in continuous use ever since.

At the Gore AFB at Great Falls, Mont.—A 7,200-foot runway and a taxiway extension were built of asphalt-concrete by McLaughlin, Inc., of Great Falls, Mont., in April 1954. Only a very small portion of the aprons were built of portland cement concrete. The Corps of Engineers highly recommended the asphalt mix which was used, according to Mr. T. P. Fish of the McLaughlin Construction Co., Inc.

At the Glynco Naval Air Station at Brunswick, Ga.—An 8,000-foot runway was surfaced with asphalt-concrete in 1952 and is still serving satisfactorily. The work was done by Duval Engineering & Construction Co., Jacksonville, Fla.

At the Cecil Field, United States Naval Air Station, Jacksonville, Fla.—The Duval Engineering & Contracting Co. installed an 8,000-foot asphalt runway with concrete ends. The work was performed in 1952, and also in 1956 and 1957. This field is standing up satisfactorily under operating conditions.

At the Naval Air Station, Jacksonville, Fla.—The Duval Engineering & Contracting Co. installed a 6,000-foot asphalt runway in 1952 which is serving satisfactorily under all traffic conditions today.

At the Turner Air Force Base at Albany, Ga.—The Wright Contracting Co., Columbus, Ga., installed a 10,000-foot asphalt runway, which has been serving satisfactorily under all traffic conditions. The taxiway and aprons are of asphalt and portland cement construction. As far as can be determined, no appreciable difference can be observed between either type of construction under the same operating conditions. The field serves bombers and fighters, according to Mr. W. S. Denton of the above-named contracting company.

At the Moody Air Force Base in Valdosta, Ga.—The Wright Contracting Co., of Columbus, Ga., installed an 8,000-foot runway of asphalt-concrete. This field has been serving satisfactorily under operating conditions, as indicated by Mr. W. S. Denton of this company, and is used largely by fighters. The aprons and taxiways are of portland cement construction.

At the Toledo Municipal Airport, J. T. Kirkby, of the S. E. Johnson Co., Maumee, Ohio, says:

"The city of Toledo, with its own funds a few years ago, constructed a flexible type (asphalt-concrete) pavement for commercial and private aircraft which has been doing a fine job with little or no maintenance cost for the pavements. In fact, I know of no cost at all for pavement maintenance up to this date."

ASPHALT CONCRETE PAVEMENTS NOW HANDLING MORE AND HEAVIER TRAFFIC THAN ORIGINALLY DESIGNED TO CARRY

Asphalt concrete can withstand a great deal of overloading and abuse, because of its flexible characteristics. After a heavy load is removed, the pavement usually springs back to its former position. In cases where permanent damage has resulted, the damaged areas have been easily repaired.

This construction explains why (flexible) asphalt concrete pavements have been so widely used throughout the world; because it is fully recognized that there is a continuing change in the requirements for airfield pavements. The entire development from very light planes to those of today's tremendous size and weight has takes place in a short time. Wheel loads have increased from 15,000 pounds in 1946 to 100,000 pounds today.

Older fields are inadequate for present-day wheel loads and have to be strengthened.

OLD PAVEMENTS STRENGTHENED WITH ASPHALT CONCRETE

The most practical way of reconstructing old fields for extra strength is to resurface with asphalt concrete. This has been done on a very large scale.

When the resurfacing has been porperly done the results have been uniformly excellent—transforming countless thousands of square yards of older surface into pavements strong enough to carry today's aircraft.

At times, false economies have produced inadequate overlays, using only 1½ inches of asphalt concrete instead of 4 inches or more as is normally required. Fields which have received this type of underdesigned surfacing are still standing up, nevertheless.

There have been cases were older pavements have been strengthened with asphalt concrete overlays and modernized to handle heavier traffic. This has occurred on many asphalt concrete and portland cement concrete pavements. Nine AF bases and municipal fields are listed:

At Chicago's Midway Airport, Illinois, an extra 2½ inches of asphalt concrete is being added to two taxiways during 1957, to enable new and heavier DC–7's to use the field.

At Geiger AFB, Spokane, Wash., one runway was resurfaced at a cost of $100,000 in 1956 by the Gibbons & Reed Co., of Salt Lake City, Utah. The Air Force is well pleased with the results. The city plans another $100,000 resurfacing with Civil Aeronautics Authority assistance during 1957.

At Lockbourne AFB, Ohio, Frank Longabough, sales manager of the Marble Cliff Quarries Co. found the field's asphalt concrete overlay in excellent condition. He said:

"I inspected the runway at the base (Lockbourne) which has 6 inches of asphalt concrete overlay over 8 inches of portland cement concrete for approximately 7,000 feet of the total 11,900 foot runway.

"* * * the original concrete runway had been constructed in 1942 and used until 1951. The surface was spalling rather badly and the asphalt concrete overlay was installed by Shelley & Sands, Inc., * * *

"Driving over the entire runway as I did, convinced me that it has held up in excellent condition. The heavy planes using this base are B–47's which weigh 190,000 pounds and land on bicycle landing gear. The base parking apron has 7 inches of asphalt concrete over the 8-inch portland cement concrete. The asphalt runway consists of 4-inch binder and 2-inch surface, plus a cover of fine gravel grit * * *

"You could also see the waterbound macadam extension of the main east-west runway at Port Columbus, which was completed about 3 years ago and surfaced with asphalt concrete. It is bearing up well with commercial passenger and freight planes plus everything manufactured by North American Aviation Co's. jet plant adjacent to Port Columbus."

At Fairchild AFB, Spokane, Wash., a 14,000-foot portland cement concrete runway and taxiways were overlaid with 4 inches of asphalt concrete by the Morrison-Knudson Co., Inc., of Boise, Idaho, in 1956, for $4,797,802. The old pavement had deteriorated badly from freezing and thawing. At this field the asphalt hardstands and taxiways have served very satisfactorily for approximately 10 years. Some slight failures resulted from repeated overloading by B–36 aircraft on taxiways. The asphalt pavement has withstood much greater loads than it was originally designed for.

At Scott AFB, Belleville, Ill., S. J. Groves & Sons Co., resurfaced two 9,000 by 150 foot runways with asphalt concrete in 1955 over deteriorated concrete. The asphalt concrete varied in thickness from 4 inches at the edges to 8 inches at the center. Not more than 2½ inches was placed in each layer. The extent of deterioration of the original concrete runways is unknown, but it is believed that spalling and general pavement roughness was the reason for resurfacing.

At Malden AFB, Malden, Mo., two 3,000-foot runways, taxiways, and aprons were built of asphalt concrete by the Thompson Asphalt Co. of Madison, Ill., for

$100,309. The construction consisted of a 6 inch stabilized base, with a 1½ inch asphalt wearing surface.

At Klamath Falls AFB, Klamath Falls, Oreg., a 10,580-foot runway was resurfaced by the Morrison-Knudson Co., Inc., in 1955 and 1956 under contracts totaling $2,500,000. Included in the work were new asphalt concrete runway extensions, portland cement concrete touchdown areas, asphalt concrete taxiways and a tar-rubber overlay on parking apron. The field is now used by the United Air Lines and West Coast Airlines. Eventually it will become an Air Force base.

At Brookley AFB, Mobile, Ala., a 4-inch overlay of asphalt concrete was placed on 4,400 feet of a 10-inch runway of portland cement concrete. The Farmer Construction Co., Inc., of the same city was awarded the $1,269,947 contract on March 21, 1957, calling for the widening and strengthening of a runway, taxiway, and warmup pad.

At the Mansfield Municipal Airport, Mansfield, Ohio (used principally by jet trainers), the 6,800-foot runway was resurfaced with 1½-inch asphalt concrete because of deterioration in the original slag base course (from chemical reaction in the slag which caused small surface ruptures). Since resurfacing, the pavements have been in excellent condition. The Mansfield Asphalt Paving Co., under a $1,168,682 contract in July–August 1953, performed the resurfacing, and constructed a 1,200-foot runway extension and taxiway of asphalt concrete.

The runway is surfaced with 2½-inch asphalt concrete over a 6-inch waterbound macadam base. Beneath that there is a 9-inch dry-bound macadam base and a 7-inch compacted subgrade.

The taxiway is surfaced with 2-inch asphalt concrete, under which is a 6-inch waterbound macadam base. Beneath this is 9-inch dry-bound macadam, and underneath that a 12-inch area of compacted subgrade.

The new construction was supervised by the Corps of Engineers.

ASPHALT CONCRETE COVERS MILLIONS OF SQUARE YARDS AT SCORES OF MILITARY BASES' CRITICAL AREAS

The Air Force's fear that large critical areas paved with asphalt concrete would be damaged from jet blast and fuel spillage has failed to materialize.

Over 15 million square yards of asphalt concrete pavements were in use at 88 major Air Force bases in the United States from which jets operated in 1954. Sixteen of these were of all-portland cement concrete. Four were of all-asphalt concrete, and 68 had large areas paved in both materials.

Compared to portland cement, asphalt concrete was used in:

Noncritical areas.—50 percent more on primary runways.

Critical areas.—About half and half on taxiways and warmup pads, and one-fourth as much on aprons, according to figures that General Washbourne gave the Hess committee:

Pavement use	Asphalt concrete (square yards)	Portland cement concrete (square yards)
Noncritical areas:		
Runways	21, 973, 706	10, 528, 013
Aprons	[1] 4, 816, 571	[3] 18, 112, 636
Critical areas: Taxiways and warmup pads	[2] 10, 998, 424	[4] 9, 211, 371

[1] 45 Air Force bases.
[2] 80 Air Force bases.
[3] 65 Air Force bases.
[4] 68 Air Force bases.

Today, 3 years later, these pavements are still serving satisfactorily on runways and in critical areas.

Experience has shown that when asphalt pavements have been properly designed, they have withstood continuous and sustained exposure to jet blast and fuel spillage with negligible, if any, damage.

In many cases, no damage at all has taken place and frequently maintenance has been entirely absent.

This has been brought out by an inspection of military and civil airfields by engineers and contractors, which has just taken place. Their detailed inspection reports are in section I 7.

Of particular significance are opinions of such men as:

Paul T. Sutton, pavements engineer of the Air Proving Ground Command at Eglin Air Force Base, Fla.;

W. J. Turnbull, Chief, Soils Division, Waterways Experiment Station, Vicksburg, Miss.; and

James T. Pyle, Acting Administrator of the Civil Aeronautics Administration.

Talking about asphalt concrete's ability to serve in critical areas at the pavements maintenance conference in Colorado, May 1956, Mr. Sutton says:

"Damage to asphalt concrete runways from jet blast effect or fuel spillage is only slight. The few cases of rutting of bituminous (asphalt) concrete pavements in the channelized area from bicycle type landing gear, along with some surface flushing which has occurred, are the exception which can be eliminated by the proper design mix and good control and inspection during construction."

Mr. Turnbull, after investigating asphalt concrete's performance, described the material's performance at the second convention of the National Bituminous Concrete Association's meeting in Chicago, February 1957:

"Asphalt concrete mixtures based on 1,500 coverages of accelerated traffic have successfully withstood prototype B–47 traffic. In the case of the several fields listed above with flexible (asphalt concrete) pavements which *have been giving trouble as a result of channelized traffic* of B–47 aircraft, *no trouble with the asphalt concrete has developed* except in *one instance where the latter did not meet design requirements*." [Editor's italic.]

Mr. Pyle accurately summed up the pavement situation in regard to commercial jets at the jet-age conference of the Spokane wing of the Air Force Association, at Spokane, Wash., in September 1956.

"The effect of jet blast and spilled fuel on paving is something which we are investigating carefully since we are deeply concerned with both new and existing construction. From what we have learned to date, it does not appear that either the blast or an occasional bit of spillage is going to do any great amount of damage."

An extract from the 1952 symposium on airfield pavements for jet aircraft is still valid, according to S. B. Hudson, of Miller-Warden Associates, highway consultants, Swarthmore, Pa.:

"Observations of pavements on airfields used by substantial numbers of jet aircraft indicate that the following can be stated as a tentative conclusion: Properly designed, well constructed, and adequately maintained dense, graded, well compacted bituminous (asphalt) concrete pavements under normal operating conditions have not been damaged sufficiently to affect the mission of the base. Where such damage has occurred in isolated cases, it can be attributed to a deficiency in design and/or construction, or to a lack of good housekeeping practice."

High-grade, hot-mix asphalt concrete placed under suitable specifications seems to stand up excellently under operations—even within critical areas.

At Bergstrom Air Force Base, Tex., a recent inspection by H. S. Kerr, vice president of the H. B. Zachry Co. (builder of Bergstrom, Kelly Air Force Bases, and other military pavements), reveals that the runway extension and taxiways built at this base in 1952–53 of asphalt concrete have withstood fuel spillage without any signs of deterioration or any other distress. No maintenance of any kind is required after continous use by B–47's, B–36's, KB–29 tankers, F–84F's, and F–84G's (which have tire pressure of 300 pounds per square inch).

At Lockbourne Air Force Base, Ohio, Col. Fred A. Spencer, commander of installations, says that the runway has been giving excellent service and has been performing to everyone's satisfaction. Taxiways and parking aprons were resurfaced with 7 inches of asphalt concrete in 1951. Scott A. Baker, executive secretary of the Michigan Asphalt Paving Association, Inc., of Lansing, Mich., inspected the field on May 8, 1957, and found that the asphalt portion still retains its original smoothness and surface texture under continuous channelized B–47 traffic, and showed no evidence of deformation.

Although exact maintenance records were not available, investigation of conditions at the field showed that practically no asphalt concrete maintenance has been needed, and none is anticipated in the future. By comparison, the portland cement concrete areas have required considerable maintenance and major repairs. Complete removal and replacement of large disintegrated areas will probably be necessary.

During Mr. Baker's inspection of the base, he was accompanied by Col. Fred A. Spencer and Colonel Britton, of the base command; Mr. J. G. King, installa-

tions engineer; Mr. John H. Goshorn, division engineer of the Asphalt Institute; and Mr. Frank Longabaugh, of the Marble Cliffs Quarry Co., Columbus, Ohio.

At Sherman Field, naval air training station, Pensacola, Fla. (described on p. A 1–10 to A 1–12), jet trainers have used an asphalt concrete runway end for years without causing any appreciable damage. On this 2-runway field, 3 of the runway ends have been portland-cement concrete and 1 has been asphalt concrete. Both types of pavement have been subjected to the same jet blast and the same operating conditions without showing any appreciable difference in serviceability and durability.

At the Mansfield Municipal Airport, Mansfield, Ohio, an inspection of an asphalt-concrete apron in front of the hangar, revealed that the pavement is in excellent condition, in spite of fuel spillage and jet blast, according to Richard R. Stander, secretary-treasurer of the Mansfield Asphalt Paving Co., of the above-named city. On an inspection tour on May 16, 1957, accompanied by Col. Albert Line, commander of the 164th Air National Guard Fighter Squadron; Fred Swineford, Macadam Pavements, Inc.; Barney Jones, Asphalt Institute engineer; R. R. Stander pointed out:

"Fuel spillage occurs continuously during the operation of Colonel Line's squadron. When the jet planes start up and stop, there is a small discharge of fuel onto the pavement. There is also fuel spillage during servicing of the aircraft and during routine maintenance operations. In order to avoid concentrating fuel spillage in small areas, the squadron changes the aircraft's parking arrangement from time to time, possibly once a month. There are no places where this has caused anything more than a slightly eroded spot, none of which has penetrated more than one-fourth to one-half inch below the original surface. This apron was built in 1950. The only noticeable effect of jet blast is a spotty reaction on the seal coat on parts of the apron surface, without having penetrated into the surface."

At McDill AFB, Tampa, Fla., the Birnson, Cone & Manly Co. resurfaced the 25-foot center of a taxiway with a 3-inch overlay of asphalt concrete, during the summer of 1953. The extra load imposed by the B–47 planes using the field necessitated this strengthening.

During the summer of 1954 and into 1955, the Cone Bros. Contracting Co., of Tampa, Fla., performed two jobs of resurfacing old taxiways. The first job consisted of a 3-inch overlay and the second job consisted of widening and resurfacing taxiway. These jobs are standing up very well, according to everyone's best knowledge.

At Loring AFB, Limestone, Maine, a flexible parking apron has been in use for the last years, subjected to about every type of aircraft operation that could be encountered at a military base. Before portland-cement concrete ends were installed about 1 or 2 years ago, the runways were subjected to jet blast and warmup common to jet aircraft by every type of plane at this base. There was no appreciable sign of damage to the runway.

At the Dover AFB, Dover, Md., prior to 1954 a large parking and fueling apron was installed for aircraft. This apron has serviced almost every kind of propeller-driven aircraft and is in good condition. Four projects were let, 3 by the Corps of Engineers and 1 by the Air Force for asphalt-concrete paving. In 1952, 367,000 square yards of flexible pavement were installed by the A. V. Williams Co., of Middle River, Md. The construction was a 6-inch dry-bound macadam base, over which a 2 to 2½-inch surface of asphalt concrete was placed. On June 11, 1954, the same contractor installed another 137,000 square yards of pavement on aircraft aprons and service roads. The design of the asphalt pavement was the same as in the first case, with the addition of a stabilized base in lieu of the dry-bound macadam.

In one of the most comprehensive analyses of jet blast and fuel spillage on asphalt pavements to date, Messrs. W. J. Turnbull and C. R. Foster presented a paper at the Jet Age Airfield Conference sponsored by the Air Transport Division of the American Society of Civil Engineers. Based on extensive tests and studies, Messrs. Turnbull and Foster summarized their findings:

"(*a*) Jet blast is critical for hot-mix asphalt concrete pavements only at the ends of runways and on aprons where maintenance run-ups are made. The effect of jet blast in other areas (taxiways and runways except the ends) is not detrimental to hot-mix asphalt concrete pavement.

"(*b*) The critical erosion temperatures of bituminous (asphalt) concrete pavements subjected to heat and blast are in the order of 250° F. for tar, 300° F. for asphalt concrete pavements, and 315° F. for rubberized-tar-concrete pave-

ments. Pavement temperatures developed by most of the United States Air Force planes operating today are less than 300° F. except when afterburners are used.

"(*c*) Operation of afterburners with the plane standing still produces high temperatures in the pavement and will cause erosion of bituminous (asphalt) pavements if continued for any appreciable period of time.

"(*d*) Occasional spillage of jet fuel on dense, hot-mix asphalt concrete pavement is not detrimental. Repeated spillage, such as that occurring on parking and refueling aprons, is detrimental because the fuel leaches the asphalt cement from the aggregate. The areas affected are relatively small. A pavement resistant to jet fuel is necessary in these areas."

ASPHALT CONCRETE CONTINUOUSLY BEING IMPROVED THROUGH RESEARCH

Although there are no drastic changes in the use and application of asphalt concrete to pavements, the science and construction methods are constantly being improved to produce better pavements—more economically.

Machinery manufacturers have also kept pace with these developments and have produced equipment which can pave large areas faster—to more exacting standards.

Continuing studies by the Highway Research Board, the individual State highway departments, the Asphalt Institute and consulting engineers give promise of superior asphalt pavements.

DURABLE ASPHALT CONCRETE PAVEMENTS BUILT TO EXACTING AIR FORCE AND CORPS SPECIFICATIONS

The Air Force's installations engineers, acting as its representatives, have inspected and recommended acceptance of millions of square yards of asphalt concrete pavements on runways, taxiways, and aprons.

Contractors using asphalt concrete have conformed to the Air Force's, the Corps', and the Navy's specifications before these pavements have been accepted. Conformance to specifications is a must, as even the best paving materials may present a constant hazard to aircraft, when incorrectly applied.

Pavements must be flat, smooth, and easy to repair with a minimum of disruption to field operations. Paving with asphalt concrete makes possible the smooth and flat surfaces required by modern aircraft.

At Robins Air Force Base, Augusta, Ga., according to the contractor, Henry H. Claussen, president of the Claussen-Lawrence Construction Co., of the same city:

"* * * The asphalt checks to closer tolerances (one-eighth inch in 16 feet) than the portland cement concrete [runway] ends."

Because asphalt concrete is constructed in two or more layers, the top surface can be made as flat as necessary. Each layer, in the process of construction, may be improved upon and any unevenness corrected by the addition of a thin layer.

Within several hours after construction, asphalt concrete is ready for use. Its durability improves with time. Since no warping or shrinking takes place, the surface of asphalt concrete remains smooth.

Should settlement of the subbase take place (caused by consolidation of the foundation)—which could happen under any surface—the pavement is restored to its original evenness and smoothness by planing, even while the airport is in use. This heating and reshaping is not possible with other material.

Restoring asphalt concrete pavements to their original condition has been brought to a high degree of perfection during the past 25 years. The machine—a heater planer—heats the asphalt surface to a workable consistency, then planes it to the desired degree of flatness and smoothness, at high speed. Upon completion, the joint-free pavement presents a continuous ribbon of asphalt which is ideal for safe aircraft use. This reconditioning is accomplished with minimum interference to airfield operations. There is no need to tear up pavements, nor is litter of old materials left in the areas.

If necessary, the runway is cleared of equipment within 2 minutes. After planing, the surface is left smooth and equal to its original construction, without burns or damage.

At Palm Beach Air Force Base, West Palm Beach, Fla., the Rubin Construction Co., of the same city, modernized runways while the base was in operation.

In a letter to the Rubin Construction Co., Col. Roy T. Dodge, contracting officer of the Corps of Engineers, said:

"* * * The contract provides that the pavement overlay on existing runways, phases 1, 2, 3, and 4 be accomplished during the period December 21–31, 1953, which required operations on a 24-hour-day basis. It also provided that the work be accomplished in such a manner as to cause minimum interference with operational activities on the airfield. It was therefore necessary that the work be well planned and coordinated to eliminate any hazard to personnel and equipment. You planned the work in a very satisfactory manner, provided the necessary equipment and trained personnel, maintained maximum safety precautions and performed the work orderly and efficiently. Your cooperation with the resident engineer and his staff and the base commander and his staff was very commendable. The result is that a hazardous but urgently needed job was completed in the minimum of time to the satisfaction of all concerned. * * *"

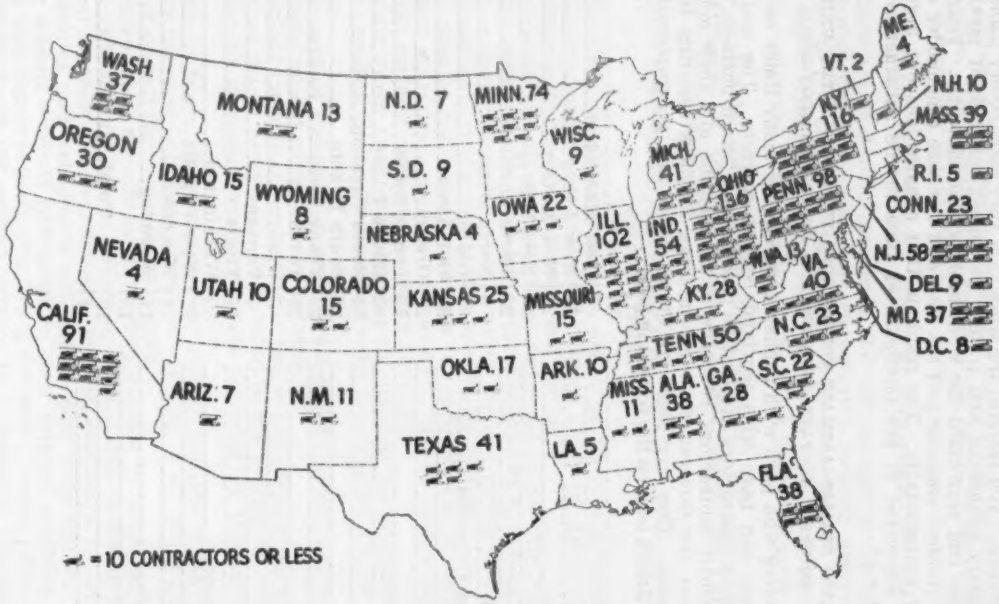
OVER 1,500 SKILLED ASPHALT CONTRACTORS THROUGHOUT THE UNITED STATES EQUIPPED TO PAVE AIRPORTS AND HIGHWAYS ECONOMICALLY

Contractors who pave with asphalt concrete are many times more numerous than those who pave with portland cement concrete. The majority of the 1,500 asphalt contractors can best be described as "small business."

The asphalt contractors' countrywide distribution and their mobility brings bidders out for Government work in large numbers resulting in the lowest paving costs. They are listed by States below and geographically shown on a United States map on the following page:

Alabama	38	Nevada	4
Arizona	7	New Hampshire	10
Arkansas	10	New Jersey	58
California	91	New Mexico	11
Colorado	15	New York	116
Connecticut	23	North Carolina	23
Delaware	9	North Dakota	7
District of Columbia	8	Ohio	136
Florida	38	Oklahoma	17
Georgia	28	Oregon	30
Idaho	15	Pennsylvania	98
Illinois	102	Rhode Island	5
Indiana	54	South Carolina	22
Iowa	22	South Dakota	9
Kansas	25	Tennessee	50
Kentucky	28	Texas	41
Louisiana	5	Utah	10
Maine	4	Vermont	2
Maryland	37	Virginia	40
Massachusetts	39	Washington	37
Michigan	41	West Virginia	13
Minnesota	74	Wisconsin	9
Mississippi	11	Wyoming	8
Missouri	15		
Montana	13	Total	1,512
Nebraska	4		

Number of Asphalt Contractors by States-1,512



SOURCE: NATIONAL BITUMINOUS CONCRETE ASSOCIATION, INC.

ECONOMIES OF ASPHALT CONCRETE REVEALED THROUGH COMPETITION

Asphalt concrete's value shows up in competitive bidding. The economies are obvious—as high as 20 to 50 percent of the total cost.

Time and time again it has been demonstrated that if options are allowed in bidding, the Government benefits from the large number of bidders and the cost is less—as much as 20 percent in many cases and more in others. This amounts to considerable sums when contracts run into the millions—as airfield pavement contracts do.

According to J. Rogers Martin, engineer-manager of the Hot Mix Asphalt Concrete Association of Oklahoma, the building of the Davis Air Base at Muskogee, Okla., as scheduled for portland cement concrete, could have been executed in asphalt concrete by many contractors in Oklahoma at savings of at least 10 percent in first cost and subsequent savings in maintenance.

Many other contracts, listed below could represent savings in the millions of dollars.

The facts are clear—shown by figures in a technical paper by Earle C. Peck, supervising civil engineer, headquarters, Technical Training Air Force, at the pavements maintenance conference held at Colorado Springs in May 1956.

Portland cement concrete costs almost twice as much as asphalt concrete for heavy-duty pavements and almost 60 percent more for light-duty pavements

Based on costs of millions of square yards of both heavy- and light-duty pavements of both types, here are how the costs compare for the period of May 1, 1953, to June 30, 1954 for—

Heavy-duty pavements

	Per square yard
Portland cement concrete	$7.05
Asphalt concrete	3.76

Portland cement costs 88 percent more ($3.29) per square yard than asphalt concrete

These costs are for pavements of either material which have been designed and constructed to carry the same load—they clearly indicate that asphalt costs are lower. Where aggregates for foundations are cheaply available, the savings are even greater when asphalt is used. Several dollars per square yard add up to huge sums. Here are costs on—

Light-duty pavements

	Per square yard
Portland cement concrete	$5.26
Asphalt concrete	3.30

Portland cement costs 60 percent more ($1.96) per square yard than asphalt concrete

Mr. Peck revealed some recent paving costs. The older prices, of course, are low in comparison with the latest USAF pricing guide which shows the cost of—

Heavy-duty pavements

	Per square yard
17-inch portland cement concrete	$10.50
Asphalt concrete	6.50

Portland cement concrete costs 63 percent ($4) more than asphalt concrete

Light-duty pavements

	Per square yard
10-inch portland cement concrete	$8.50
Asphalt concrete	5.50

Portland cement concrete costs 55 percent ($3) more than asphalt concrete

These cost analyses are based on the most complete information, and show that: it costs one-third less to build with asphalt concrete today ranging from $3.64 to $3.90 per square yard based on 1954 and recent figures.

These facts were brought out in Brig. Gen. R. E. L. Eaton's letter to Hon. Carl Vinson, chairman, Committee on Armed Services, of June 15, 1953, where he stated:

"During the past 18 months, under this policy (competitive first cost on 2 pavement types) the Air Force has constructed approximately 60 percent of its pavement in the flexible type (asphalt concrete) and 40 percent of the rigid type (portland cement concrete). The dollar cost of the two types of pavement has been approximately equal."

Restated, this amounts to an extra 50 cents on each dollar for portland cement concrete.

ASPHALT PROVEN ECONOMICAL AT 26 AIR FORCE BASES BY THE ASPHALT INSTITUTE AT THE HESS HEARINGS

This fact is amply illustrated by the comprehensive studies conducted by the Asphalt Institute, at 26 Air Force bases.

Use of asphaltic concrete represented savings to the Air Force of over $26 million on pavement projects, according to estimates and actual bids. This was listed in appendix, pages 259–265, of Airstrip Pavement Materials hearings before the Subcommittee on Defense Activities of the Committee on Armed Services, House of Representatives, 83d Congress, 2d session.

The figures cover the period from January 1951 to March 1954. Possible savings over a longer period of time would easily be many times those shown—running well over a hundred million dollars—when the 350 Air Force bases, with hundreds of millions of square yards of pavements, are considered.

The Asphalt Institute's cost comparison between asphalt concrete and portland cement concrete at 26 Air Force bases, are shown in detail on pages B1–5 through B1–8.

Cost comparisons of asphalt concrete and portland cement concrete at 26 Air Force bases

Airport	Loading and pavement part—(R—runway, T—taxiway, A—apron)	Area (square yards)	Asphalt concrete (AC)			Portland cement concrete (PCC)			Saving using AC	Remarks
			Design total depth (inches)	Unit cost	Total cost	Design total depth (inches)	Unit cost	Total cost		
Tye Air Force Base, Abilene, Tex.	A, T, and R ends	503,800	36-50	$4.50	$2,267,100	22	$5.73	$2,886,774	$619,674	
Edwards Air Force Base, Muroc, Calif.	150,000 case II, R	810,000	56	[1] 4.15	3,361,500	40	5.96	4,827,600	1,466,100	Unusually low for PCC.
McClellan Air Force Bzse, Sacramento, Calif.		76,995	31	3.01	307,725	14	3.97	456,260	148,535	PCC awarded on Air Force demand.
Kinross Airfield, Mich		97,555	10		427,273	7-10	3.42-4.31	562,200	134,927	Low PCC bid where competition is present.
Brookley Air Force Base, Mobile, Ala.		252,950				16-17	6.37-6.67			No competitive bids taken.
Limestone Air Force Base. Limestone, Maine.	Heavy and light	928,000	70	5.37	1,084,740	70	11.98	2,418,960	1,335,220	PCC is over twice AC's cost for same strength. All AC construction would have saved $1,335,000. All PCC would have cost an excess of $3,000,000 for 464,000 square yards.
McGhee-Tyson Air Force Base. Knoxville, Tenn.	Light A and R	214,300		3.26-3.61		9-10	385-4.03		57,200	Low PCC price where alternate bids were taken.
Donaldson Air Force Base, Greenville, SC.		238,000	12	3.01	608,380	8	3.36	798,600	49,737 190,220	Do.
Brookley Air Force Base, Mobile, Ala.	Light	13,252	13½	3.71	191,583	8-10	4.29	207,005	15,422	Do.
Forbes Air Force Base, Topeka, Kans.					2,765,079			3,236,176	471,097	(3).
Lincoln Air Force Base, Lincoln, Nebr.	A	632,570	32-46	8.22	5,198,100	8-20	3.86-8.47	5,353,525	155,425	Small difference where alternate bids were taken. Awarded PCC in spite of higher cost.
Altus Air Force Base, Altus, Okla.		786,140	26-32	[2] 2.68-2.71	2,122,580	16-17	[4] 6.08-6.44	[5] 5,031,296	[2] 2,908,718	PCC would have cost almost 2½ times as much as AC.
Smoky Hill Air Force Base, Salina, Kans.					1,543,650			1,685,420	141,590	
Carswell Air Force Base, Fort Worth, Tex.			31	5.61	2,380,988	18	6.41	2,604,361	223,373	
Hunter Air Force Base, Savannah, Ga.	100,000, A, T, R	1,028,300		[2] 2.64-4.22		12-15	[2] 5.60-7.00		[2] 3,007,487	PCC cost spread per square yard is 80 percent higher than AC.
MacDill Air Force Base, Tampa, Fla.	100,000, A and T	835,250	Overlay	2.03-3.50		12-15	5-00-6.50		[2] 2,450,681	Savings on this airport.

See footnotes at end of table, p. 2193.

Cost comparisons of asphalt concrete and portland cement concrete at 26 Air Force bases—Continued

Airport	Loading and pavement part—(R—runway, T—taxiway, A—apron)	Area (square yards)	Asphalt concrete (AC)			Portland cement concrete (PCC)			Saving using AC	Remarks
			Design total depth (inches)	Unit cost	Total cost	Design total depth (inches)	Unit cost	Total cost		
Pinecastle Air Force Base, Orlando, Fla.	100,000, A and R	943,350		$2.95–3.67		15–16	[5] $6.22–7.55		$3,443,514	Savings on this airport.
Donaldson Air Force Base, Greenville, S. C.	Light, A and R	302,351		2.53		6–10	3.30–3.60		303,520	Do.
Homestead, Dade, Miami, Fla.	Heavy A	385,000		[5] 2.50		15	[5] 7.00		1,732,500	Gen. L. B. Washbourne informed Asphalt Institute representative that job would be all AC because it was cheaper.
Stewart Air Force Base, Nashville, Tenn.	Light A	178,550		[5] 3.66		10	[5] 4.05–4.87		115,202	
Canton-Akron, Ohio			20		$206,994	20		$312,994	105,706	
Fort Campbell, Ky	R and T				984,711			1,220,340	235,630	Yardage and unit prices unavailable.
Wold-Chamberlain Air Force Base.	T and A	36,300	31		373,480	22		392,200	18,740	Low PCC cost where alternate bids are taken.
Westover Air Force Base, Chicopee Falls, Mass.	Heavy and light	836,685	9–26	2.05–2.66		23	6.59			AC price is $3.93 less per square yard than PCC on same strength design. If all AC had been used, savings would have been $3,288,271.
Portsmouth (N. H.) Air Force Base.	Heavy	941,450	36–50		6,429,700	48		10,766,600	4,336,900	Originally designed for all AC. Now being redesigned for PCC. Note over $4,000,000 or 68 percent increased cost for PCC.
Schenectady County Airport, N. Y.		210,000	[6]		1,020,580			1,298,796	278,216	If pavement alone had gone to low bidder, Government would have saved $278,216. Difference in total bids is not a true picture because many items, other than pavement, are bid and may be unbalanced in price.
Plattsburg Air Force Base, Plattsburg, N. Y.	Heavy, A, R, T, and warmup pads.	928,043	16–18	3.61–3.76	[7] 3,463,292	13–14	5.78–6.62	5,629,712	2,166,622	Saving on this airport if all asphalt were used.
Total savings using asphalt concrete.									26,111,956	

NOTE.—This information presented to the Hess committee in 1954 by the Asphalt Institute.

EXPLANATORY NOTES ON COST COMPARISONS

The bases on which alternate bids were taken (or reliable estimates were made) show the possible savings through the use of asphalt concrete. The following footnotes accompany the bids shown on pages — through — and are taken from the Hess hearings, page 264.

[1] Estimates.

[2] This project was awarded to the Kaw Paving Co. on their asphalt-concrete bid. After the contractor had moved in all his equipment and plant, and started construction, a directive from Washington ordered the Corps of Engineers to cancel the contract and renegotiate a contract for portland-cement concrete. I (Arvin S. Wellborn, chief engineer of the Asphalt Institute), am confident that the contract for rigid-type pavement was certainly less than the bid figures show for this type of construction. On top of that, the Corps had to settle with the Kaw Paving Co. for work performed by them, and liquidated damages for which I do not have the figures.

[3] Bid prices.

[4] Corps of Engineers prices.

[5] Unit prices are based on either bid prices of comparable items on same project or Corps of Engineers estimate.

[6] Paving only.

[7] Alternate bids were not taken on these items, the costs used were based on low bid on same design in taxiways. On the larger quantities involved, the cost could be expected to be lower. Note that if pavements alone had been let to low bidder on asphalt, the savings to the Government would have been $2,166,622. The difference between low bids ($328,817, not shown in table) does not reflect the true difference between pavement types because, as in this case, several million dollars worth of other items, subject to unbalanced bids, were thrown into the same contract.

NOTE.—From 21 to 36 inches top of embankment is given special compaction under grading for both types of pavement.

During the Air Force's recent pavement program, between 350 to 800 million dollars were at stake at 350 to 400 bases, depending on the pavement material choice.

As brought out in the cost-comparison tables on pages 2191 through 2192, economies of $26,111,622 at 26 Air Force bases were traceable to asphalt concrete. These figures were based on either actual bids or reliable engineering estimates.

At one Air Force base, savings amounting to $3 million were realized in using asphalt. Average savings of 1 to 2 million dollars at each Air Force base frequently occur.

On some bases there were overexpenditures from the exclusion of asphalt—at others, economies through its use.

At the Plattsburg Air Force Base, N. Y., an overexpenditure of $2 million resulted because portland-cement concrete was used, instead of asphalt which was cheaper. The portland-cement concrete was $6.07 compared to $3.73 per square yard for asphalt concrete.

Portland-cement concrete cost 63 percent more ($2.34 per square yard) than asphalt concrete at the Plattsburg Air Force Base

At the Homestead Air Force Base, Fla., savings amounted to $3 million (as brought out at the Hess hearings), through the use of asphalt.

A recent cost comparison at Dow Air Force Base, Maine, shows the difference in price between the two pavement materials for a new runway. An asphalt-concrete contract was renegotiated in favor of portland-cement concrete at $2,964,401 extra.

Large economies are possible at the Sheppard Air Force Base runway at Wichita Falls, Tex., according to J. Rogers Martin, engineer-manager of the Hot-Mix Asphalt Concrete Association of Oklahoma, Inc.

"* * * Changing the present 2-foot thick (portland-cement concrete design to a 4-foot asphalt) design would result in savings from $2 million to $3 million.

"* * * We in the asphalt-concrete contracting industry stand on the record of proven adequacy of asphalt-concrete pavements. The Corps of Engineers can design, and we can build this runway of asphalt concrete to perform at least as satisfactorily as a portland-cement concrete pavement, and at 10 to 20 percent less cost."

OLD PAVEMENTS BEEFED UP WITH ASPHALT CONCRETE—COSTS ARE FRACTION OF NEW CONSTRUCTION

If the cost advantages for asphalt concrete are impressive in new construction, they are indeed spectacular for resurfacing and strengthening old pavements.

You can't keep surfaces from wearing. In addition, new aircraft and equipment impose heavier loads upon the pavements than they were built to withstand, making modernization necessary. As an example, the design wheel loads during 1946 were 15,000 pounds and are 100,000 pounds now. Climatic changes and chemicals also add their toll to pavement deterioration and necessitate resurfacing—to obtain smooth surfaces.

Asphalt is the natural material for modernizing pavements. A very expensive and long-duration job is required if portland cement concrete is used. Either the old pavement has to be completely removed and replaced, or a new portland cement concrete slab placed above the old. Frequently this overlay is thicker than the original pavement, and costs more.

Not so with asphalt concrete. The cost is very small for resurfacing an old pavement—just a fraction of a new one.

Actual costs for resurfacing two Air Force bases with asphalt concrete were brought out by J. Rogers Martin of the Hot Mix Asphalt Concrete Association of Oklahoma.

"For the repair of an extensive failure of an old base at Tinker and Altus Air Force Bases, $1½ million would be required for asphalt concrete compared to a $5 million portland cement concrete slab."

Faulty construction at Pinecastle Air Force Base required the reconditioning of the east runway. Under a $171,287 contract for proof-rolling, subgrade stabilization and resurfacing two 20- by 200-foot strips, this asphalt-concrete way is being compacted and strengthened without interfering with present operations. This is a small sum for restoring an improperly built runway (caused by uncompacted subsoil). The average cost was $1.24 per square yard.

The difference in repair costs is demonstrated by noting price of repairing a small portion of portland cement pavement at the Mountain View Air Force

Base, Colo. Replacing and repairing 8,473 square yards of overloaded pavement cost $125,000—an average cost of $14.90 per square yard.

Compare this with the asphalt concrete at the same base. The 125 square yards were repaired for $500—and average cost of $4 per square yard.

It cost four times as much to restore the portland cement at Mountain View Air Force Base as it cost to restore the asphalt concrete.

A recent example shows the cost of a thin experimental portland cement concrete overlay at Selfridge Air Force Base at Mount Clemens, Mich. This modernization of 30,000 square yards, with a 1- to 1½-inch thick portland cement concrete overlay cost $3.49 per square yard. The usual portland cement concrete overlay is much thicker and, of course, many times more expensive.

Many new asphalt-concrete pavements have been built from the ground up for prices within this range.

ASPHALT-CONCRETE COMPETITION KEEPS PAVING COSTS DOWN

What would happen to airport paving prices if there were no asphalt-concrete competition, was stated at the 1954 hearings of the Subcommittee of Defense Activities by Congressman Charles P. Nelson's questioning of General Washbourne:

"General, suppose the Air Force, as you indicate you might like to do, should specify that nothing but concrete be used in Air Force pavements, what do you expect would happen to the price of concrete?"

General WASHBOURNE: "I think the concrete people, contractors, would be smart enough to realize that competition had been lessened, and they might take a few liberties with their bidding."

Mr. NELSON: "Competition had been lesened? They wouldn't have any would they?"

General WASHBOURNE: "Yes, sir."

Mr. HESS: "Among themselves."

General WASHBOURNE: "These contractors, Mr. Nelson, are in a position to offer you anything you want and among themselves they still have to go out and get these jobs. I don't think the nature of the competition would result in materially different prices. But I have to agree with you, that if asphalt were completely out of the competition, it wouldn't be quite as sharp."

In the State of Oklahoma, there are four times as many contractors who are equipped to do asphalt-concrete paving as there are portland cement concrete contractors. But recently, contract specifications at Davis Field, Muskogee, Okla., kept the local contractors out of the picture. They could not bid, as asphalt-concrete options had been omitted from the specifications.

It is obvious that this technique will drive up paving prices.

There are over 1,500 skilled and competent contractors throughout the United States who are in the asphalt-paving business. In addition to handling paving jobs for the Government economically, obtained by competitive bidding, these contractors keep down portland cement concrete paving prices. Otherwise, the Government would be paying a higher price for its pavements now.

MAINTENANCE COSTS ARE THE SAME FOR BOTH PAVEMENT TYPES

Maintenance records at military airports are hard to compare, but it was stated at the Hess hearings that both types of pavements cost the same amount of money to maintain. The portland cement concrete pavements require continuous joint filling, which explains their high maintenance cost.

This is further brought out by State highway department studies of maintenance costs. Experience from highways is applicable to airfield pavements as the heavy and continuous stream of traffic on highways subjects pavements to extreme stress. The effect upon the wearing surfaces of each type of pavement would be similar.

The Oklahoma Turnpike Authority studied the problem thoroughly and found that maintenance costs for all heavy-duty pavements were very close. Massachusetts, Pennsylvania, and other States indicated that properly built asphalt pavements cost about the same amount to maintain as other types.

Asphalt has been preferred because of its immediate use which makes highways usable as soon as paving is completed.

It is interesting to note that asphalt is used to maintain and repair portland cement concrete pavements.

Cost figures showing repairs and maintenance at Mountain View AFB, Colo., are shown on the following page.

PAVEMENT MAINTENANCE AND REPAIRS AT MOUNTAIN VIEW AFB, COLORADO, 1956

PAVEMENT TYPE	FAILURE	REASON	EXTENT (SQ. YDS.)	REPAIRS	COST
Asphalt Concrete	Surface Raveling	Poor Drainage	125	Drain Fixed – Surface Relaid (IE Personnel)	$500
	Surface Erosion	Jet Blast & Heat	3 Small (1 x 3) Blast Pads	Eroded Areas Patched (IE Personnel)	$ 50
					$550
Emergency Project	Rapid & Severe Cracking of Slabs Over Wide Range	Overloading by Heavy Aircraft	140	Replacement	
Portland Cement Concrete	Wide Range of Cracks	Overloading	8,333	Strengthening (by Contract)	$125,000
	Slabs Settled	Poor Drainage 2 Slabs Settled Over Storm Drain	Small Area	Drain Pipe Cleaned (by IE Personnel)	$ 1,300
					$126.300

Presented at the Pavements Maintenance Conference, May, 1956, Colorado Springs, Colorado, by:

Leslie B. Crowley, Jr., Chief, Pavements and Railroads Section, Maintenance Division, Assistant Chief of Staff, Installations, USAF

ASPHALT CONCRETE INSTALLED FAST, USED IMMEDIATELY WITHOUT DELAY

Because asphalt concrete can be used within hours after placement, it has a tremendous advantage over other pavements which cannot be used for a long period of time, as they require curing. Portland cement concrete pavements have to age 2 to 3 weeks after placement to reach strength. As a result, any new construction, repairs, or replacements tie up new airport facilities for weeks, even after construction is finished.

In case of emergency pavement repairs, asphalt concrete would undoubtedly be the material used.

It seems advisable, then, to keep the contractors who make these repairs, interested in military airport work and to acquaint them with the specialized paving problems involved. In the event of an emergency, they can then put their familiarity with military requirements to use immediately.

Just such an emergency situation, where asphalt contractors performed with efficiency and dispatch—to the country's benefit—was vividly brought out at the 1954 Hess hearings by Mr. B. Grey, former Asphalt Institute president.

"It is important to emphasize the part played in the use of asphalt after Pearl Harbor, when the country's desperate situation required immediate building of a large number of airfields with hastily assembled engineering and contractor organizations. Some of the surfaces were made scanty indeed in order to get operations underway, and it is a wonder that many served as well as they did. It is to be noted further that practically all of these fields built for the lighter weight propeller-type aircraft have been capable of adaptation to satisfactory use under jet-type planes with heavier and more intense wheel loads and their peculiar service conditions. Without the asphalt pavements then so quickly made available, we would have been in sorry condition indeed."

Asphalt pavements can be constructed more rapidly than other types of pavement since no curing period is required other than for the hot-mix to cool to air temperatures. They are in use within hours.

An indication of how important lost time can be during the building of a new runway was illustrated at the Geiger AFB during the November 1956 first contract bid: According to O. H. Mills of the United Paving Co., Inc., one of the considerations in the schedule of the portland cement concrete contract was that 2 days each week would be lost as small crews would have to be used not to interfere with the field's operations.

A great advantage of asphalt, under emergency conditions, is that only a smaller weight of binder needs to be transported to the job. Only about 5 percent of the material is asphalt. The rest is obtained locally. Such material as crushed stone, gravel, slag, or selected soils for the foundation, are most always obtained near the work site.

Thus, while there is substantial thickness of the composite pavements, the asphalt wearing surface is only a few (3–5) inches thick. The comparable design for portland cement concrete may be three times as thick for the wearing layer. The base for the flexible (asphalt) pavement is placed with this locally available material.

As brought out by Mr. Grey at the Hess hearings, the relative tonnage would be an important factor in case of an emergency.

"* * * heavy-duty pavement, capable of carrying the weight of the heaviest planes, requires, in the case of concrete, from 250 to 300 pounds of cement per square yard, whereas only 18 to 30 pounds of asphalt are needed. This would seem a very important item and particularly under wartime conditions where transport is so much required for all other uses."

Mr. Grey pointed out another factor: "Another important advantage of asphalt is its reaction under bombing, and something that deserves consideration in the building of any military field. By its very nature, there are no large broken fragments to be removed. Moreover, it is possible to stockpile asphalt repair mixtures in advance so that the bombed areas can be immediately replaced and under use. Thus it seems appropriate to state that under wartime conditions asphalt would be the most logical material for all advance bases for transport and repair reasons alone."

Since portland cement concrete is used in so many areas, during an emergency, there is a great possibility that shortages can develop and the material would not be available for repairing damaged runways.

Asphalt, on the other hand, can be stockpiled at the site and used at any time. Since it is a residue from oil refining, it would always be in plentiful supply.

An example of how fast these pavements can be resurfaced was illustrated recently in the New York City area. The Grand Central Parkway was resurfaced with asphalt concrete during the night hours, without interrupting the heavy traffic which it carried as one of this area's main arteries. Within a short time the entire pavement was resurfaced—one lane at a time, without inconvenience to motorists. It is still operating successfully afer several years of use. Any other method of repair would have tied up this main artery for months.

Low-grade aggregates can be used in asphalt concrete. These are readily available in practically every region of the United States. Portland cement concrete requires high quality aggregates which are not always available and have to be transported. Delays may occur as a result. In some areas shortages of these high quality aggregates are becoming apparent.

Asphalt paving utilizes local materials and local contractors without taxing our transportation facilities or pocketbooks.

HESS HEARINGS O.K.'D ASPHALT CONCRETE

At the Hess hearings, it was conclusively established that when properly designed, either asphalt concrete or portland cement concrete can serve military aircraft operations effectively. At these hearings and in subsequent investigations, the committee, engineers, and construction men showed beyond doubt that asphalt concrete pavements are serviceable, strong, and durable.

They have been serving both military and civilian airports for over 25 years and handling heavier traffic than they have been designed for. After thorough investigation of the situation, the following specific points were established:

1. The Air Force definitely preferred portland cement concrete.

2. It was paying a 5-percent premium for its preference, based on the overall cost of the project. This amounted to as much as 40 percent extra when figured on paving costs alone.

3. The 5-percent figure was picked out of the air. One job was receiving bids with a price differential of 10 percent in favor of portland cement concrete while the committee was in session.

4. According to testimony by the Army Corps of Engineers, asphalt concrete pavements perform equally as well as portland cement concrete in the normal operation of aircraft. Furthermore, General Washbourne specifically stated at the hearings that asphalt concrete, as well as portland cement concrete could be designed to take any load.

5. The investigating committee took the position that neither asphalt nor portland cement concrete by itself eliminated the hazards caused by poor housekeeping. The committee understood the desire of operating commanders to have the best kind of fields, but did not agree that the best airports were necessarily the most expensive.

6: Nor did the committee feel that the Air Force should bind itself to a rigid and undeviating specification of only one particular kind of pavement material.

The 5-percent differential referred to in the Hess hearings was an overall cost on an airfield, including all of the projects within this airfield such as lighting, grading, and other construction work.

The competition was so weighed by preferential differentials in favor of portland cement concrete that it was extremely difficult for asphalt concrete to show its full economy. It didn't only apply to the difference in price between the two respective pavements; it was figured on the complete cost of the airfield.

Many times it was brought out that as much as 25- to 35-percent savings could have been effected on pavements by using asphalt concrete. Because the total construction costs were used as the basis for judging the 5-percent difference the Air Force has been overpaying on its pavements.

At that time, design criteria called for the use of rigid portland cement concrete pavements on runway ends, warmup pads, and portions of taxiways.

The Hess committee concluded that a continuation of this design criteria for the critical areas was proper, and that for the remaining portion comparative costs should be weighed and the price differential discontinued.

The Air Force accepted this decision on August 16, 1954, in a letter to the Honorable William P. Hess, written by Mr. John M. Ferry, special assistant for installations for the Department of the Air Force.

In this letter, we quote Mr. Ferry:

"This is to inform you that we have completed a review of all available information from the field which has a bearing on the subject. While we are

completely convinced that 100-percent concrete has a definite advantage as compared to a combination of portland cement concrete in the critical areas and asphalt in the noncritical areas, we have been unable to collect adequate engineering backup as reflected by maintenance cost to substantiate this. It is apparent that the problem does not lend itself to a simple conclusive solution based on the facts procured by a short-term study. We have, therefore, suspended premium payments for cement concrete in noncritical runway areas."

After indicating that instructions were issued to Air Force and Corps of Engineers personnel concerned to comply with the Hess hearings, Mr. Ferry concludes:

"*It is my understanding that this action is in accordance with the views of your committee* which held hearings and secured information from many interested sources." [Emphasis supplied.]

Mr. Hess acknowledged Mr. Ferry's letter on August 19, stressing the fact that there was not adequate engineering support to justify paying a 5-percent premium for portland cement concrete. Mr. Hess said:

"I have your letter of August 16, 1954, advising that the Air Force had verified that there is *not adequate engineering support to justify paying a 5-percent premium* for concrete airstrip paving over asphalt pavement in noncritical areas on airfields.

"That same conclusion was reached by the subcommittee after a full and open hearing on the subject in May of this year.

"I am glad to have your advice that the price differential criteria of January 8, 1954, has been withdrawn by the Air Force." [Editor's italic.]

AIR FORCE EXTENDS CRITICAL AREAS—VIRTUALLY ELIMINATES ASPHALT CONCRETE

After agreeing to the decisions reached at the Hess hearings, the Air Force embarked upon a course of eliminating asphalt concrete from primary areas, in addition to the designated critical areas.

On December 20, 1955, the Honorable Franklin G. Floete, in a memorandum directed to Hon. Donald A. Quarles, Secretary of the Air Force, permitted a redesignation of the critical areas. The new designation took in all of the major paved areas, with the exception of overruns, shoulders, and erosion control areas.

Without change in policy, simply by extending the noncritical areas, asphalt concrete was virtually eliminated for all future airfields, without regard to whether heavy or light loads were involved.

The reason—channelization of pavements under B–47 and B–52 loads—does not apply to light aircraft, such as training and fighter planes. Yet the directives cover all pavements at all fields.

The new policy outlined by Secretary Floete cites an exhaustive study conducted for his Department by an architect-engineer, with the following conclusions:

"* * * that presently available paving methods, other than portland cement concrete, do not possess the necessary qualities of stability and endurance under heavy concentrated loadings, high air temperatures, and jet-engine blast and fuel spillage.

"Analyses of these reports and reviews of other reports of airfield pavement failures and resultant interferences with operational and training programs have been made by my technical staff. These indicate that portland cement concrete is the best material currently available of which hard, durable pavements with a smooth surface and nearly uniform gradients can be designed and constructed with reasonable assurance that they can be maintained to meet satisfactorily the requirements of the immediate future for the efficient, sustained, and full-capacity operation of modern high-density, high-speed military aircraft."

This policy was implemented shortly thereafter, as would be expected. Asphalt concrete was eliminated from new construction, even to the extent of renegotiating contracts which had already been awarded.

The nonasphalt concrete policy applied to all airfields, except where Air Force contradictions crept in.

Asphalt concrete pavement contracts have been awarded by the Air Force despite its own directive. One instance where this took place was at the Columbus, Miss., SAC Air Force Base.

This contract was awarded during November 1956.

But 11 months before, the Air Force found asphalt concrete so undesirable that they banned it from primary runways. The Columbus AFB is a SAC base and points up the contradiction in policy as originally outlined by Secretary Floete. Acting Secretary of Defense, Mr. A. McDonald, restated this policy:

"Airfield pavements for the direct support of Air Force combat missions within the continental United States must be ready and available at all times. Asphaltic concrete on the primary runways and taxiways, when subjected to the very heavy wheel loads, high tire pressures, and the traffic patterns of current Air Force jet aircraft, has become unstable and has failed. Various surveys and tests already have been made. * * *

"* * * At the present time, it appears that portland-cement concrete is the best material currently available of which hard, durable pavements with smooth surfaces and nearly uniform gradients can be designed and constructed with reasonable assurance that they can be maintained so as to meet satisfactorily the requirements for safe, efficient, and sustained full-capacity operation of modern high-density, high-speed military aircraft."

The reasons for some of these reversals of Air Force policy should be explained.

The devices by which the Air Force has cut back on asphalt-concrete pavements in noncritical areas are discussed in the next chapter.

AIR FORCE USES THREE DEVICES TO ELIMINATE ASPHALT-CONCRETE COMPETITION

The Air Force has not abided by its Hess Committee agreement permitting competitive asphalt-concrete options in military airport paving. As a result, there have been excessive expenditures.

They have been so numerous, it is not possible to show where all of them have taken place, so just a few are pinpointed in the following pages. These partial listings amount to:

Excessive expenditures of $6,830,081

The total amounts involved are much larger.

This is a direct result of the Air Force's arbitrary policy of eliminating asphalt-concrete from option bidding on competitive military airfield contracts. This policy was mentioned in Engineering News Record's February 21, 1957, issue on page 90.

"On the military side of the airport picture however there was big and spectacular enough news:"

"The Air Force," said Air Installation's Chief, Lee W. Washbourne, "will be building no more runways with flexible-type (asphalt) pavements."

About 15 months before this statement was made (December 20, 1955) the critical areas on military airports were extended so that practically all asphalt paving was eliminated. Not only have many contractors been virtually deprived of the opportunity to bid competitively on military-airfield contracts, but the Government, too, has suffered a deprivation because:

Fewer bidders tend to increase the cost as competition is lessened, and
An economical construction method (asphalt concrete) is eliminated.

The Air Force's three very effective devices

1. Renegotiating asphalt-concrete low bids and substituting portland cement concrete at a higher price—frequently in the millions on each contract. This occurred many times and is pointed out at three AF bases:

	Excessive expenditure
Dow AFB, Bangor, Maine: Here the extra tariff amounted to	$2,964,401
Grand Forks, N. Dak., AFB: Estimated additional cost	474,878
Alexandria AFB, Alexandria, La., where the extra came to	324,270

2. The withdrawal of asphalt concrete options from bids already advertised: Portland-cement concrete had the field completely to itself, as competition from asphalt concrete was absent. The price went up at many AF bases—seven are pointed out here:

Charleston AFB, Charleston, S. C	----------
George AFB, Victorville, Calif	50,000
Davis Monthan AFB, Tucson, Ariz	185,000
Sherman-Clinton AFB, Clinton, Okla	----------
Kingston Naval Air Station, Orange Grove, Tex	----------
Geiger AFB, Spokane, Wash	201,532
AFB (unnamed), Puerto Rico	----------

The same practice was used on a road at Roosevelt Road, Puerto Rico.

3. The complete omission of asphalt-cement options from Department of Defense contracts, without regard to the type of area involved, took place many times and is pointed out at six AF bases:

Sheppard AFB, Wichita Falls, Tex	$2,500,000
Davis AFB, Muskegee, Okla	130,000
Olmsted AFB, Middletown, Pa	----------
Toledo Airport (Air National Guard), Huntington, W. Va	----------
Davis AFB (Apr. 3, 1957), Muskegee, Okla	----------
Amarillo AFB, Amarillo, Tex	----------

1. ASPHALT CONCRETE "LOW BID" CONTRACTS RENEGOTIATED, SUBSTITUTING HIGHER PRICED PORTLAND CEMENT CONCRETE AT THREE AIR FORCE BASES

At Dow Air Force Base, Bangor, Maine, a renegotiation of an asphalt concrete runway to portland cement concrete amounted to an excessive expenditure of $2,964,401.

The extra cost resulted from the different type of construction when asphalt concrete was eliminated from the original contract—at almost double the original price.

This example illustrates the excessive costs arising from the Air Force's arbitrary exclusion of asphalt concrete.

The original bids listed portland cement concrete at $4.70 a barrel on October 28, 1955, and the same price was shown on the renegotiated bid when figured during July 1956. Other material items appear not to have varied appreciably in price. Nor did the cost of labor differ during this period.

The only apparent reason for this large increase in cost came about from the new portland cement concrete (rigid pavement) design.

The Grand Forks Air Force Base, N. Dak., which was originally part-asphalt and part-portland cement concrete on a contract awarded for a runway, was changed to all portland cement concrete.

This contract was awarded to S. J. Groves & Sons Construction Co. in December 1955 on the basis of their low bid—both on portland cement concrete, and on asphalt concrete:

Portland cement concrete	$4,961,277
Asphalt concrete including portland cement concrete ends	4,486,398
The asphalt-concrete was cheaper by	474,878

The lowest bid originally accepted was renegotiated for portland cement concrete, resulting in an (estimated) excessive expenditure of $474,878. (NOTE.—The difference in bids originally made between portland cement concrete and asphalt concrete is used as the estimated additional cost of the changeover.)

The only asphalt which appears to have been used in this project, from the best available information, was on the roads and streets within the housing area.

At Alexandria Air Force Base, Alexandria, La., an unnecessary expenditure of $324,270 resulted because a resurfacing contract was negotiated. No engineering reasons for the switchover were given beyond saying that crushed gravel was to be used for the base course. This material was available from Fort Smith and Big Rock, Ark. The contract was awarded to T. L. James Co. during May 1955 for the construction of hot-mix asphalt concrete taxiways, a hot-mix asphalt concrete overlay on a runway with 1,000-foot portland cement concrete ends; using hot-mix asphalt concrete shoulders and blast pads.

The following contract modifications took place: The—

Asphalt concrete shoulder paving was deleted;

Asphalt concrete taxiway was changed to portland cement concrete;

Asphalt concrete runway overlay was changed to portland cement concrete.

The portland cement concrete overlay thickness varied from 9 to 17 inches.

The original asphalt concrete contract called for 63,000 tons. The deletion of the shoulder paving and changing the taxiways to portland cement concrete reduced the tonnage to approximately 32,000, about half.

The runway overlay was changed to portland cement concrete which resulted in an adjustment of the portland cement concrete price to $11.20 per cubic yard.

The portland cement concrete overlay thickness varied from 9 to 17 inches.

The 36,000 cubic yards of portland cement concrete used to complete the overlay of the 6,000-by-150-foot runway section reveal an average thickness of 13 inches. Based on this thickness, an estimated cost of the asphalt concrete overlay was calculated for comparison with the portland cement concrete cost.

Asphalt concrete

4 inches asphalt concrete	$155,680
9 inches crushed aggregate base course	130,250
Total cost	285,930
Portland cement concrete	610,200
Asphalt concrete	285,930
The asphalt concrete was cheaper by	324,270

Not using asphalt resulted in an excessive expenditure of $324,270.

2. WITHDRAWAL OF ASPHALT CONCRETE OPTIONS

In the second case, where asphalt concrete options were withdrawn from bids already advertised, and portland cement concrete was substituted, there are many examples to illustrate this practice.

At Charleston, S. C., asphalt design was changed to a portland cement concrete overlay and extension. No estimate available on extra cost.

At George Air Force Base, Victorville, Calif., under contract No. DA–04–0353, there was a switch-over from asphalt concrete to portland cement concrete. Although the precise cost cannot be determined, unofficial estimates show that the result was an excessive expenditure of $50,000.

At the Davis-Monthan Air Force Base in Tucson, Ariz. (under contract No. DA–04–0353 Eng. 4662), the change order required the deletion of asphalt concrete and the substitution of portland cement concrete by the contractor on the job. This substitution was for the extension of a main runway, approximately 1,200 feet long. No official estimate of the cost was available, but engineering calculations approximated the increased excessive expenditure at $185,000.

At the Sherman Clinton Air Force Base, Clinton, Okla., under a contract awarded to Peter Kiewit Sons, of Wichita, Kans., for $7 million and another contract to Nolan Bros. of Minneapolis, Minn., a stop order was issued on the asphalt paving during the summer of 1956. The 13,500 by 300-foot runways were to have been of asphalt concrete construction, except for the 1,000-foot ends which were originally of portland cement concrete.

The new design called for 16-inch portland cement concrete for the entire runway, over a 6-inch filter course of stone and in addition to 8 inches of stabilized subgrade. There are 50-foot-wide shoulders on each side of the runway which are of asphalt concrete.

The Navy was the construction agent on this contract. No estimate available on extra cost.

At the Kingston Naval Air Station, Orange Grove, Tex., another instance of an arbitrary switch-over took place in June 1956. The contractor was J. M.

Dellinger, Inc., of Corpus Christi, Tex. No estimate available on extra cost.

The Geiger Air Force Base, Spokane, Wash., contract was advertised on October 1956 under the 1954 criteria for asphalt concrete runways with portland cement concrete ends.

The corps' estimates were exceeded and, as a result, the contract was not awarded.

The original specifications on the Geiger Air Force Base were very rigid in the opinion of many contractors.

The contract was then readvertised under two schedules:

Schedule A consisted of a design following the 1954 criteria as originally advertised in October 1956.

Schedule B consisted of all portland cement concrete construction. This added the runways to the critical areas calling for portland cement concrete only.

The lowest bid on schedule A was $169,000 less than schedule B—using asphalt concrete on the runway—approximately 6.7 percent of the overall cost. Grading, lighting, and other construction work on the job was included in this percentage.

The lowest bid on schedule B was $201,532 above schedule A which was bid by another contractor—about 15.8 percent more when the paving alone was considered. (The actual dollars do not correspond on these two comparisons because different unit prices were used.)

At a public meeting of contractors the Corps of Engineers announced that bids would be awarded strictly on low price. In spite of this announcement the contract was awarded to the higher priced schedule B. The job was given to another contractor. This decision was made in Washington, resulting in an excessive expenditure of $201,532.

At an airfield in Puerto Rico, there was an alternate bid allowing asphalt concrete construction. Before the bids were received on May 1, 1956, the option was withdrawn and only portland cement concrete allowed. This was for a 5,800 by 200-foot runway. Other areas were originally specified for portland cement concrete for what were probably critical areas. These were 1,900 by 200 feet by 11 inches, 3,400 by 50 feet by 6 inches and 3,250 by 200 feet by 6 inches. No estimate available on extra cost.

In Puerto Rico, on Roosevelt Road, in this case a road contract, the original proposal called for alternate asphalt concrete bids. The alternate was withdrawn before bids were taken on May 1, 1956. The contractor was Blythe-Mills Co.

3. OMISSION OF ASPHALT CONCRETE FROM COMPETITIVE BIDDING

GOVERNMENT PAYS INCREASED PAVEMENT PRICES

As General Washbourne has pointed out, the Air Force does not prefer asphalt concrete pavements. Although many reasons have been given, the inconsistencies show that in some cases lightly loaded runways had the same "no-asphalt" policy as runways for which the given excuses applied.

Omission of asphalt concrete options from contracts took place at the following Department of Defense airfields:

At the Sheppard AFB at Wichita Falls, Tex., under contract No. 34-066-57-51, the runway, taxiway, and aprons were designed without any provision for alternate bidding from asphalt concrete.

The district engineer's (Tulsa) invitation allows asphalt concrete for shoulders only in their specifications:

"Construction of approximately 990,000 square yards of portland cement concrete runway, taxiways, aprons, overrun and blast pad, and approximately 190,000 square yards of asphalt concrete shoulder stabilization. Work will also include grading, drainage, airfield marking, and ducts from airfields lighting."

In the opinion of Mr. Bryant M. Collins, president of the Hot Mix Association of Austin, Tex.:

"From estimates on the above airfield, if you had continued your criteria as per your 1954 standards, and limited the rigid design pavement (portland cement concrete) to critical areas only, you would have effected a saving on this job of between 2 to 3 million dollars." The average (estimated) excessive expenditure was $2,500,000.

At the Davis AFB, Muskogee, Okla., asphalt concrete was not included as an option on pavement bids.

Only six contractors submitted bids for the job (for which the low bid was slightly over $1,300,000)—all of these bidders were out-of-State contractors.

According to Mr. J. Rogers Martin, engineer-manager of the Hot Mix Asphaltic Association of Oklahoma, Inc.:

"Oklahoma contractors were not in a position to bid on the type of design presented. In our opinion, alternate competitive bidding would have drawn bids from at least 10 Oklahoma contractors.

"This would, without doubt, have resulted in at least 10-percent savings on first cost and also a savings of maintenance." The estimated excessive expenditure was $130,000.

At Olmsted AFB, Middletown, Pa., bids for aprons, taxiways and a runway were opened on September 15, 1956. Asphalt concrete options were not allowed on this 211,000 cubic yards of new construction. Also included were 75,000 cubic yards of portland cement concrete for overlaying existing pavements. No estimate available on excessive cost.

At the Toledo Airport, the Air National Guard, through the Corps of Engineers at Huntington, W. Va., asked for bids on portland cement concrete only, to the exclusion of asphalt concrete.

According to Mr. Kirkby of the S. E. Johnson Co., contractors of Maumee, Ohio:

"Soil conditions at the Toledo Airport are ideal for asphalt concrete and certainly the performance of the existing pavement would seem to have been justification for continuing the same design for the Air National Guard. However, the Air Corps has been adamant in its opposition to asphalt concrete pavements and has been unwilling to even consider asphalt concrete."

On the new northwest-southeast runway and taxiway No. 6 at Davis Field, Muskogee, Okla., on invitation No. Eng. 34–066–57–43 on April 3, 1957, the option showed that asphalt concrete construction was not included.

This runway is specified to be of portland cement concrete. This field has a relatively short runway and the possibility is remote that it could be used for heavy plane operation. No estimate available on extra cost.

At Amarillo Air Force Base, Amarillo, Tex., 950,000 square yards of portland cement concrete were to be bid on by May 8, 1957. No alternate asphalt concrete bids were specified, except on overruns. No estimate available on extra cost.

AIR FORCE'S INACCURATE STATEMENTS NEEDLESSLY HURT ASPHALT CONCRETE INDUSTRY

Remarks by policymaking officers of the Air Force show numerous inconsistencies and fail to explain their dislike of asphalt concrete pavements. Official policy banned this method of construction 17 months ago—yet it's being used in new runways as well as strengthening and repairing older pavements.

Of greater importance is the nagging question of what is to be done with half of our present pavements which are built out of this banned material.

Asphalt pavements which were built before are handling today's air traffic—but the same asphalt pavements are not good enough for more of the same traffic—according to the Air Force's statements.

Gen. L. B. Washbourne doesn't want any asphalt pavements, yet the Air Force continues to build them. Gen. Curtis LeMay says that we have only two air bases which can handle B–52's Strategic Air Command's needs—both of which are paved with asphalt concrete. Mr. P. T. Sutton, pavements engineer of the Air Proving Ground Command prefers asphalt concrete.

Statements by these men require more detailed examination to bring the inconsistencies into focus. Here are some of them:

In the January 7 issue of this year's Newsweek, Gen. Curtis LeMay warned of our inadequately equipped bases:

"Only two United States fields—at Merced, Calif., and Limestone, Maine—are properly equipped to handle the huge intercontinental bombers. Other bases are in England, North Africa, and Guam. LeMay wants alternate bases built, both in the United States and abroad—fast. Despite claims that the B–52 is fast flying into obsolescence, the Air Force is not freezing its design. In fact, improvements are now being made to make it higher, faster, a poorer target." Newsweek continued:

"Strategic Air Command brass believes the B–52 will give the United States good retaliatory protection for 5 years. By then, they hope the intercontinental guided missile should be perfected." General Washbourne's statement at the Mahon hearing:

"We agree, Mr. Chairman. They (asphalt concrete contractors) are still bidding and getting most of the bids on all of our road work, and other things other than this high-performance airfield pavement."

"You can get laboratory blacktop pavement that will do the job, but we just find that the contractors by and large do not produce laboratory type blacktop pavement on our bases, and whenever anything goes wrong with these pavements, for whatever reason, the Air Force always has to pay the bill for getting it fixed. We just feel that the uncertainty of any lesser pavement than this concrete should not be put into this big program:

Isn't this true of all pavements, General Washbourne?

Erroneous impressions have been picked up in the press as a result of these blanket condemnations by the Air Force. The impression that only asphalt fails is obviously inaccurate in the light of General Washbourne's statement at the pavement maintenance conference:

"Though new pavement will obviously require less maintenance, there is not an immediate program to replace the millions of yards of existing pavement built to lesser criteria. Only increased maintenance can make up for the underdesign. You will be confronted with spalling, broken slabs, base failures and similar problems for a long time to come."

Inaccurate statements have needlessly hurt the asphalt industry and the contractors and material suppliers who comprise it. In one case, the damage has crept over into the civilian field.

Recently, at the Miami International Airport, there has been a hesitancy to consider asphalt for an expansion program because of the general detrimental remarks about this type of construction.

One, made by Gen. L. B. Washbourne before a large group of contractors at the February 1956 meeting of the Associated General Contractors, was by itself strong enough to be responsible for this type of thinking:

"Concrete (portland cement) can take it, blacktop can't." More specific statements, which didn't stand up under investigation, blamed asphalt concrete for almost every pavement difficulty. But, difficulties on all pavements from "bicycle-landing" aircraft have been revealed by the Air Force, the Corps of Engineers, the Highway Research Board and consulting engineers.

The Altus Air Force Base was one of the old and overloaded slabs that General Washbourne was referring to. The failures were in the area where old portland cement concrete slabs were overlaid with asphalt concrete. The base was not able to carry the load and failed, but asphalt concrete was blamed.

Typical of how these inaccurate statements are picked up in the press is shown by the Daily Oklahoman's February 10, 1956 headline:

"Asphalt Cracks Up at Altus Airfield," Altus, February 9 (staff).

"The Air Force has authorized replacement of more than 329,000 square yards of asphalt pavement on the aircraft parking apron of Altus Air Force Base with portland cement concrete."

Enginering News-Record's November 8, 1956, issue revealed the marathon-type of contest by which asphalt was put out of the running:

"The Air Force has won its right to use portland cement in preference to asphalt on air bases. The Asphalt Institute, downed in recent tests, is trying now to mix a new batch that can get them back into the running."

"Result of a competitive test at Kelly Air Force Base this summer—set up by the Air Force and the Army engineers at the request of asphalt interests—was a smashing success for concrete. Asphalt officials admit that as things stand now, they have no argument with which to persuade the military to accept bituminous pavement for airfields on runways, taxiways, and other airfield pavements."

"The test compared the two types of pavement under simulated repeated loadings of heavy aircraft—a load of 100,000 pounds. The concrete strip was built to military specifications. Asphalt design and construction were controlled by the Asphalt Institute for this test.

"Test procedure called for 30,000 load repetitions of dual-wheel landing gear. The asphalt strip began to show distress at about 3,000 loadings and became so badly rutted at 9,000 loadings that the testing of the asphalt pavement was discontinued. However, at the end of 30,000 repetitions on the concrete pavement, it showed no signs of deterioration."

Basically the same column appeared in the magazine Construction Methods. By a single pavement test asphalt was branded unsatisfactory in a marathon winner-take-all decision.

Sound engineering rather than showmanship is what's called for. New planes call for new requirements—from men and materials. This, in turn, calls for research and coordination of efforts.

Pavements are in this category.

ASPHALT STANDS UP UNDER OPERATIONS AND AIR FORCE CRITICISM; CORPS, NAVY, HIGHWAY RESEARCH BOARD, AND AF ENGINEERS APPROVE IT

In spite of frequent public statements by leading Air Force officers criticizing asphalt concrete in general terms, these pavements have been very serviceable and are standing up—frequently under loads far beyond those for which they were designed.

Many Air Force officers, and other personnel connected with the Air Force in a technical capacity, not only feel that asphalt is serviceable but they actually prefer asphalt concrete to portland cement concrete.

The truth of the matter is that all pavements have trouble because today's planes are much heavier than when the majority of existing pavements were designed. A constant repair and strengthening program is required to keep pavements in serviceable condition.

Because soil conditions vary in each locality it is difficult to compare the advantages of one pavement with another as a different design is called for to achieve economy and durability.

ARMED SERVICES FIND ASPHALT CONCRETE SATISFACTORY

Perhaps better than most men, Mr. Paul T. Sutton, pavements engineer, of the Air Proving Ground Command, United States Air Force, summed up the situation on Air Force policy and practicability of asphalt concrete at the pavements maintenance conference last May in Colorado Springs. Speaking of the recent criteria on new construction of primary runways, he says:

"* * * pavement will normally be constructed of portland cement concrete with exceptions considered on request to Headquarters, USAF. From this, the observer can only conclude that, if he can afford it, he will be much better off with a portland cement runway."

Commenting on the serviceability of asphalt concrete runways, Mr. Sutton went on to say:

"We have under construction at Eglin Air Force Base [Fla.] a 12,000-foot-long, 300-foot-wide, heavy-duty runway, designed for channelized traffic. Warmup aprons and parking aprons, being constructed in conjunction with it are portland cement which is, in my opinion, the best type of pavement for this particular usage. With the exception of 1,000-foot-portland-cement sections of concrete at either end of the runway, however, the runway and taxiway are asphalt concrete."

Mr. Sutton covers other factors, by saying:

"Damages to asphalt concrete runways from jet blast effect or fuel spillings is only slight. The few cases of rutting of bituminous concrete pavements in channelized areas from bicycle-type landing gear, along with some surface flushing which has occurred are the exceptions which can be eliminated by the proper design mix and good control and inspection during construction."

Talking of maintenance, Mr. Sutton says:

"The problem inherent in rigid type pavements of joint maintenance is eliminated as well as the prospect of being faced with what could be a very costly project in case of failure of extremely thick slabs now required for channelized traffic. In the event that wheel loads are designed still further in the future, either from inservice loading or aircraft-design flexible-type pavement will lend itself more readily to strengthening to meet these additional loads, as well as being more economical to repair in case of pavement failure due to overloading."

Mr. Sutton continues:

"If it is decided to construct runways using the rigid [portland cement concrete] pavements, certain localities having soils in the low K-value in aggregates producing a low flexual strength concrete will have pavement thicknesses exceeding 2 feet in the channelized area, if present design methods are followed. These extremely thick slabs are going to present problems due to internal stresses set up from warping caused by temperature differential of the top and bottom surfaces. To eliminate this problem as well as to effect a possible economy in construction, the traditional concept of rigid [portland cement concrete] pavements as a slab whose strength is increased by adding to its thickness might well be discarded in favor of reinforced or prestressed sections in the channelized areas."

Discussing the maintenance of pavements in permafrost areas where ground movement is a constant problem, R. E. Menge, of the Northeast Air Command, had this to say about asphalt pavements, at the pavements maintenance conference:

"* * * Maintenance of failures is more difficult to perform in rigid [portland cement concrete] pavement than it is in flexible [asphalt concrete] pavement."

From the Waterways Experimental Station, Messrs. Turnbull and Foster, Chiefs of the Soils and Flexible Pavement Branches, respectively, have this to say about failures blamed on asphalt concrete:

"Asphalt concrete mixtures based on 1,500 coverages of accelerated traffic have successfully withstood prototype B–47 traffic. In the case of several fields listed above (March Air Force Base, Pinecastle Air Force Base, Altus Air Force Base, Davis-Monthan Air Force Base) with flexible pavement which have been giving trouble as a result of channelized traffic of B–47 aircraft, no trouble with the asphalt concrete has developed except in one instance where the latter did not meet design requirements."

HIGHWAY RESEARCH BOARD FINDS ASPHALT CONCRETE SATISFACTORY

At the Department of Defense's request in July 1954, the Highway Research Board appointed a special committee of engineers to study the effects of aircraft operations on military airfield pavements. This committee, composed of engineers eminent in their particular fields, conducted the study and reported their findings.

The purpose of this study was to develop information so that a Defense Department policy for airfield pavements could be established—one which would be practical and economical.

The study included:

Inspection of the 27 Navy, Marine, and airbases within the United States.

Observation of results at three Army engineer and Navy airfield paving laboratories where heat, blast, and spillage effects were tested.

A consideration of the indicated trends, in military aircraft design and operation within the next decade.

The committee's findings and recommendations are listed.

Investigated: Heat, blast, and fuel spillage

Spillage of jet-aircraft fuel has

Little effect on the surface of portland cement concrete pavements, other than staining and discoloration.

Some softening and deterioration of joint sealer for portland cement concrete pavements, and some staining of asphalt concrete pavements and (if repeated frequently) softening and eventual disintegration of the pavement.

Where jet planes were kept moving, heat and blast had little effect, if any, on ether type of pavement.

Where planes remained standing with engines running, heat and blast had little effect on portland cement concrete itself, but softened, melted, smeared, and eroded the joint sealer. Had some effect on asphalt concrete while planes were standing.

Recommended for heat, blast, and fuel spillage

Either portland cement or asphalt concrete for the central portions of taxiways and runways where planes are moving continuously.

Portland cement concrete for pavement, in certain "critical areas," such as maintenance and fueling areas, warmup pads, aprons, and on those runway and taxiway portions where planes are stationary with running engines.

Critical areas should be based upon the type of field operation, runway and taxiway layout, and economic considerations. The final decision should be based on sound engineering judgment in which all factors, including operational requirements, will be given full consideration.

PAVEMENT FAILURES TRACED TO MANY SPECIFIC FACTORS NOT CAUSED BY MATERIALS OR BASIC TYPES OF CONSTRUCTION

Runways become obsolete, the way planes do. As planes get heavier, pavements are subjected to more and more concentrated loads. The result—pavement failures.

The main causes of pavement failures may be designated as—

Overloading.
Poor design.
Poor coordination among personnel.
Improper maintenance.

In some instances, insufficient knowledge of the many factors encountered with new aircraft.

What's needed, as has been brought out by many engineers in the military services and in the paving industry, are pavements that are appropriate to meet operating conditions. Specifically, proper design, construction and maintenance, and the incorporation of new findings in daily operations are called for. Also, research into better ways for overall operations.

The Air Force's complaints of pavement failures at seven of its bases were traced, upon investigation, to one or more of the above factors. These were the findings of the Corps of Engineers, in some cases the base commanders, the Asphalt Institute, and the National Bituminous Concrete Association, Inc. The method of construction, or materials used, have not been at fault. Messrs. Turnbull and Foster [1] pinpointed the causes at five AF bases.

Lake Charles AFB, La.: Cracking of pavements.
March AFB, Calif.: Compaction in subgrade.
Pinecastle AFB, Fla.: Compaction in subgrade.
Altus AFB, Okla.: Plastic deformation in base and subbase.
Davis-Monthan AFB, Ariz.: Plastic deformation in paving mixtures.

PAVEMENT FAILURES CAUSED BY POOR DESIGN

Asphalt concrete stands up both under actual operations and in tests. This is demonstrated by the minimal needed repairs—both in dollars and pavement area.

This point is emphasized in the aforementioned paper by Messrs. Turnbull and Foster:

"* * * asphalt concrete mixtures based on 1,500 coverages of accelerated traffic have successfully withstood prototype B–47 traffic. In the case of the several fields listed above with flexible (asphalt concrete) pavement which have been giving trouble as a result of channelized traffic of B–47 aircraft, no trouble with the asphalt concrete has developed except in one instance where the latter did not meet design requirements."

The specific causes for failure are treated in the following pages.

FAILURES AT THREE AIR FORCE BASES CAUSED BY POOR CONSTRUCTION

Failures at three AF bases were traced directly to poor construction in an investigation conducted by the corps at:

March AFB: Compaction in subgrade.
Pinecastle AFB: Compaction in subgrade.
Altus AFB: Plastic deformation in base and subbase.

The exact causes for these failures are treated elsewhere.

POOR COORDINATION RETARDS RESEARCH

Insufficient coordination between top-level aircraft designers and engineers responsible for airfield pavement research, is brought into focus by the Highway Research Board's investigation of 27 military aircraft bases.

Although aircraft is planned 5 years or more in advance, fiscal limitations prevent long-range planning by those in the service responsible for pavement research. Result—a dearth of knowledge regarding future pavement requirements.

COMPETENT MAINTENANCE ESSENTIAL FOR LONG LIFE OF AIRFIELD PAVEMENTS

It has been generally acknowledged that proper maintenance is essential to continuous and safe aircraft operation, and to protect the large investments they involve. Nevertheless, few steps have been taken to insure the realization of these objectives.

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[1] W. J. Turnbull, Chief of Soils Division, Waterways Experiment Station, CE, Vicksburg, Miss., and C. R. Foster, Chief of Flexible Pavement Branch, Soils Division, Waterways Experiment Station, CE, Vicksburg, Miss., presented a joint paper at the 2d annual convention of the National Bituminous Concrete Association, held in Chicago, Ill., in February 1957.

The cost for maintaining pavements is low enough, as has been brought out by G. C. Gill, captain, United States Navy, in his June 15, 1953, letter to Mr. John J. Courtney, special counsel, Subcommittee on Defense Activities, Committee on Armed Services:

"* * * it was found that the difference between the maintenance costs for the flexible [asphalt concrete] pavements and portland cement concrete pavements was negligible. It is considered that 3 cents per square yard per year is the average maintenance cost for all pavements."

"* * * The fact that the costs were practically the same for both types of pavements appears strange, until one considers that the resealing of joints on concrete pavements is a reoccurring and a costly procedure plus the fact that to repair a section of concrete [portland cement] pavement usually requires the complete replacement of a panel, whereas a flexible type [asphalt concrete] pavement may be repaired in much smaller sections."

It is interesting, in this connection, to note the statement by P. T. Sutton, pavements engineer, at the pavements maintenance conference held at Colorado Springs, Colo., in May 1956. In part, he said:

"* * * the problem, inherent in rigid [portland cement concrete] type pavements, of joint maintenance, is eliminated * * * by proper design mix and good control and inspection during construction * * *"

The most recent findings by the Highway Research Board (during their survey of 27 military airfields) point up the great need for proper maintenance, a need that has been sorely neglected. Corrective measures are suggested.

What's needed are special maintenance crews supervised by a permanent informed staff, whose job it will be to keep pavements in top operating condition and to eliminate hazards. Pavements will last longer, as a result. General carelessness in maintaining pavements in a readiness condition was found at most fields. In many instances the maintenance work done was inadequate.

Many airfields are actually without patching or repair equipment. Out of 22 airfields, only 12 had the necessary means for sealing joints. Inadequate equipment for upkeep was found responsible for poor pavements.

In numerous instances necessary materials for small repairs were not available and corrective action was delayed until the damage was so extensive it then had to be repaired under contract. This entailed interrupting operations until repairs were completed.

According to observations by the Highway Research Board, here are some specific examples of poor maintenance on many fields:

Spalled portland cement concrete pavements were patched with poorly compacted cold asphalt mixtures.

Portland cement concrete edges which had broken and spalled had irregularly feathered edges.

Asphalt concrete patches were poorly and roughly finished.

Placing of asphalt seals was done without repairing blast damage or other defects.

The Highway Research Board strongly recommended:

Using the same good materials for repairs as for initial installation. Pavement damage in the future would then be minimal.

Availability of repair and maintenance manuals, so that all personnel connected with maintenance could be equally instructed through this interexchange of advanced technical information—essential for informed coordination between services and units of airfields.

Maintenance and protection of shoulder pavements against natural erosion and blast effects.

PORPOISING CAUSES STILL AN UNKNOWN ON ALL TYPES OF PAVEMENT

One of the most frequently voiced public statements of the Air Force, criticizing asphalt runways has been related to the "porpoising" effect which jars the plane and its delicate human occupants and electronic equipment.

The Air Force's solution—announced many times by its air installations chief, Lee B. Washbourne—was to have smoother pavements. Flat and smoothness tolerances of one-eighth inch per 16 feet was the rule laid down.

Asphalt pavements were built to these tolerances and accepted by the Corps and Air Force's installations engineers. Asphalt contractors have conformed to these smoothness requirements at many fields. At the Robbins Air Force Base, to mention one, the tolerance of one-eighth inch in 16 feet was strictly adhered to as specified, by the Claussen-Lawrence Construction Co., of Augusta, Ga.

"The asphalt checks to closer tolerances than the portland cement concrete ends," according to Mr. Henry H. Claussen, president of the company.

In fact, asphalt concrete has been used to smooth out rigid (portland cement concrete) pavements in many cases.

Then—suddenly—the flatness and smoothness specifications were relaxed—just weeks ago.

Why?

Does the letup in flatness requirements mean that General Washbourne's statements on dangers to aircraft and personnel because of porpoising no longer apply?

Does it mean that asphalt pavement's blame for porpoising was not so severe as stated, since smoothness is no longer so important?

Whatever the reasons, it was established at the grade control conference called by the South Pacific Corps of Engineers in San Francisco, January 25, 1956, that many factors are responsible for porpoising on both asphalt and portland cement pavements. Much remains to be learned about the reasons for porpoising before it can be completely eliminated. No one reason is at fault always, but here are the main facts that come to the fore:

1. The contractors present agreed that with their equipment pavements could be built to tolerances of plus or minus one-fourth inch. Air Force requirements later on, however, proved stricter. How long the pavements would hold up at that degree of smoothness remained unanswered.

2. New machinery would be needed to build smoother pavements. Asphalt concrete pavements can be made smoother because they are placed in many layers. Any slight deviation can be corrected in the next layer.

3. The Air Force did not as yet know the permissible deviation that it could accept without dangerous porpoising of its B–47's and B–52's.

The Corps of Engineers and the Air Force decided to conduct a joint survey of heavy bomber fields on both asphalt and portland cement runways to observe the present deviations. So far no one factor explains the porpoising problem in full.

1. Porpoising occurs on both asphalt and portland cement pavements. There is no correlation between cause and effect.

2. Many factors enter into porpoising. With the exception of one surface irregularity at Castle Air Force Base, no outstanding runway conditions could be held responsible for porpoising.

3. Porpoising cannot be attributed solely to runway roughness, according to Major Nix, a B–47 commander, "The plane's characteristics, themselves, may be at fault. The B–47 has a tendency to porpoise. Pilot technique and landing the nose wheel first is the most important cause."

4. Not one case of malfunctioning of electronic instruments from porpoising or runway roughness, showed up when investigated by the Highway Research Board.

5. Surface maintenance neglect seemed the most widespread cause of porpoising.

6. Asphalt pavement complaints were traceable to faulty construction and subbase consolidation, not to the pavements themselves, according to Mr. Krutson.

7. Porpoising was blamed on a slight hump in the pavement at Davis-Monthan Air Force Base, although more severe humps did not cause this effect. Humps can't be the only cause, then.

8. Contractors' opinion was that proper sized aggregates at March Air Force Base and accurately operating the paver would probably solve the smoothness problems.

9. Clearly, more research is needed into the cause and solutions of porpoising. Fields now operating successfully should be used as a guide to study the problem, it was agreed.

POOR HOUSEKEEPING THE CAUSE OF JET ENGINE DAMAGE

One of the Air Force's most frequently voiced complaints about asphalt concrete has been that loose aggregates enter jet engines, resulting in frequent overhauls and at times requiring complete engine replacement.

The pavements maintenance conference of May 1956 brought this matter into proper perspective. The main cause of damage was traced to poor housekeeping.

Although there is need for research to find the most effective means to prevent particles' entry into jet engines, the most important prerequisite is clean pavements. Many factors contribute to the $18 million annual engine damage, such as jet blasts, and foreign particles from all sources. The National Advisory Committee for Aeronautics disclosed the following important facts:

1. Asphalt-concrete pavements permit particles to move in many directions and as a result they are not forced up.
2. Portland-cement pavements, with their cracks and joints, often wedge particles, which are then blown as high as 8 feet when subjected to dislodging jet blasts.
3. The larger the particle the greater the damage. A one-eighth inch pebble's effect is minor; a one-half inch bolt can totally destroy an engine.
4. Foreign objects can enter the engine in many ways—natural winds, prop wash, exhausts from other jets, etc.
5. Poor housekeeping and out-of-date pavement sweepers result in tools or parts being left on pavements or in engines. Research and new machinery are called for to effectively remove these objects at frequent intervals.
6. The best solution offered yet is to get these objects off the pavements before they can get into the engines, by cleaning up debris near airports and screening the intake portions of the engines.

HOW ASPHALT CONCRETE WAS PUSHED OUT OF MILITARY PAVING COMPETITION

Until 1950 price alone determined the choice between asphalt concrete and portland cement concrete for military paving. The ability of each material to do the job has been recognized by all. Then, around 1950, when jetplanes took to the sky, the picture on the ground changed.

The effect of spilled jet fuel and blast on pavements led to the designation of "critical" areas. Here concrete was specified. In all other cases, asphalt—which has been successfully serving on half our military pavements—could be used. But only if the price on the entire contract was at least 5 percent less. Since a great deal of other work was normally lumped into a contract. asphalt lost out, even when 25 to 35 percent less than portland cement concrete. The Hess committee thoroughly investigated this procedure and concluded that there was no basis for it. The discontinuance of premium payments for portland cement concrete was agreed to by the Air Force as a result of the hearings.

The "critical" areas defined in 1954 were extended on December 20, 1955, at the Air Force's request. As a result, new asphalt concrete construction was virtually pushed off military airfields.

Asphalt has lost the freedom to compete for military pavement contracts. That much is clear and certain. The reasons for this situation are not quite so clear. They invite further study.

History in capsule form

Here is a chronology of events by which asphalt's competitive position was negated for military pavements (brought out in the subcommittee of the Committee on Appropriations, House of Representatives, 84th Cong. 2d sess., by the subcommittee on Department of the Air Force Appropriation with the Honorable George H. Mahon acting as chairman of the committee):

1950 to August 1952

"Competitive bids on asphalt concrete and portland cement concrete pavements. Contract award based on low bids. Observation of the deleterious effect of spilled jet fuel and the temperature and velocity of jet exhaust on asphalt pavement during this period prompted the establishment of 'critical areas' where only concrete would be permitted. These areas were aprons, warmup pads, 1,000-foot runway ends, wash racks, and calibration platforms."

August 1952 to January 1954

"Use of concrete on 'critical areas.' Competitive bids on asphalt and concrete pavement on all other areas with contract award based on low bid. Observations of rutting and other indications of structural weakness in asphalt pavement subjected to the channelized type traffic pattern of B–47 aircraft during this period prompted establishment of a 5-percent premium allowance to concrete in the evaluation of competitive bids."

January 1954 to August 1954

"Use of concrete in 'critical areas' and use of concrete also in other areas, if it could be obtained for no more than 5 percent above the bid for asphalt. During this period, a House Armed Services subcommittee held open hearings on the propriety of Air Force criteria. The subcommittee findings con-

firmed a requirement for concrete in 'critical areas' but suggested deletion of the 5-percent premium allowance to obtain concrete in other areas. This was done."

August 1954 to December 1955

"Same as the period August 1952 to January 1954. During this period the Office of the Secretary of Defense arranged for the conduct of independent investigations and the Air Force observed and reported continuing failures of asphalt pavement under channelized B–47 aircraft traffic. Request was made to OSD for use of concrete for all primary use pavement. This request was approved December 20, 1955."

December 1955 to present

Use of concrete for all primary use airfield pavement. Apparently, toward the end of 1955 there was confusion, then a quick change of mind, within the Office of the Assistant Secretary of Defense, with regard to the relative merits of asphalt and portland cement concrete pavements. Queried on the subject by the Asphalt Institute, Secretary Franklin G. Floete replied, on January 6, 1956:

"Rigid-type airfield pavement has been specified as a requirement for critical areas for some time, and either flexible [asphalt] or rigid [portland cement concrete] types of airfield pavement for noncritical areas on the basis of lowest first cost. This is still the policy of this Department."

Two weeks before, on December 20, 1955, he had already informed a member of the House Armed Services Committee:

"* * * that available paving methods, other than portland cement concrete, did not possess the necessary qualities of stability and endurance under heavy concentrated loadings, high air temperatures, and jet-engine blast and fuel spillage."

And on the same date, by memorandum to Hon. Donald A. Quarles, Secretary of the Air Force, Secretary Floete:

"* * * permitted to be named as critical areas all the paved portions of airfields except shoulders, runway overruns, and erosion-control areas."

This move, in effect, completely eliminated the use of asphalt concrete pavements on all future airfields to be constructed and used by combat and combat-support aircraft. And with no official change in policy.

March 11, 1957

Airfield paving specifications were revised by the Corps of Engineers. The new criteria for grade and smoothness tolerance relaxes the adherence to one-eighth inch flatness for every 16 linear feet of runway to one-eighth inch in 12 f et of runway longitudinally, and three-sixteenths inch in a 12-foot transverse direction.

Viewed in the light of continuous public statements that valuable aircraft and lives were endangered because runways weren't flat enough, it appears odd that the Air Force has agreed to a relaxation of its previous flatness requirements.

THE KELLY TEST FROM ENGINEERING TO MARATHON

What started out as an engineering test at Kelly Field, on May 5, 1956, ended up as a marathon where one material's inability to pass a theoretical test doomed its future in military. This not-good-enough test strip has been serving as a connecting taxiway for the past year, and is in excellent condition.

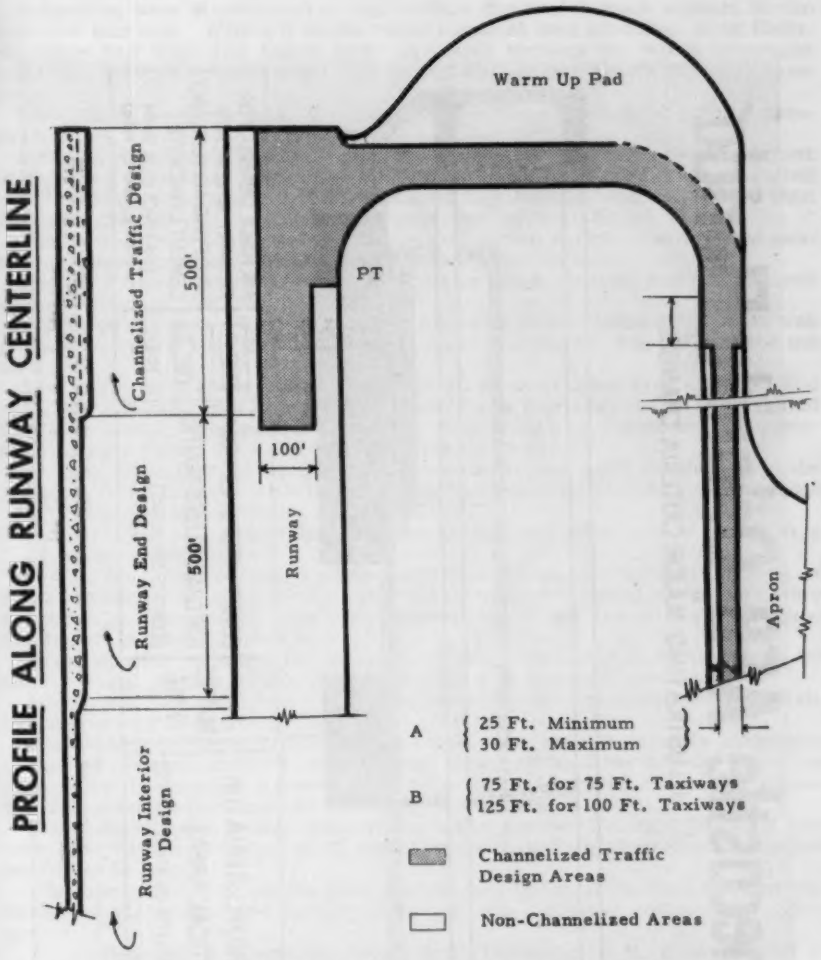
It was a winner-take-all decision, except—

Asphalt concrete had already been banned from the picture 5 months before by a Department of Defense order (December 20, 1955) at the Air Force's request.

General Washbourne's January 20, 1956, letter to all commands implemented this directive, eliminating asphalt from runways and taxiways. Then, the Air Force proceeded to test asphalt concrete at Kelly on May 5, 1956—100 days later.

Two test strips—one of portland cement concrete and the other of asphalt concrete—were to be subjected to 30,000 coverages at high temperature (180,000 landings and takeoffs) far beyond anything which could be encountered in operation.

The asphalt concrete surface had not been designed for the theoretical test loads which could never be encountered in practice.



TYPICAL LAYOUT OF AREAS TO BE DESIGNED FOR CHANNELIZED TRAFFIC

USAF Installations Engineering Specification 56 - 35

Pinecastle AFB, Orlando, Florida
ILLUSTRATING MAJOR CRITERIA CHANGES
DESIGN CRITERIA FOR CRITICAL AREAS
FEB 3, 1954
(COMMITTEE ON ARMED SERVICES)
CORPS' INTERIM CRITERIA FOR CHANNELIZED TRAFFIC
MAY 25 1956
(CORPS OF ENGINEERS)
P.C.C.
DEC. 20, 1955
AIR FORCE CRITERIA FOR PRIMARY PAVEMENTS SPECIFYING ALL PORTLAND CEMENT CONCRETE
(AIR FORCE TECM. 56-34 (1001.2) (MAY 25, 1956)
Information source: Jackson Paving Company, Jacksonville, Florida
National Bituminous Concrete Association, Inc.

Although asphalt concrete surfaces have been built to withstand these loads and coverages, the surface at Kelly was not designed for 30,000 coverages at high temperatures.

It was designed for 1,500 coverages (prototype traffic).

The surface sustained 8,605 coverages.

Difficulties were encountered in the surface due to too much asphalt in the mix—for this test. Within 6 weeks under identical load condition as at Kelly, the corps had built and tested large pavement sections for 30,000 coverages (this was a 100,000-pound wheel load at 200 pounds per square inch tire pressures).

They simply used less asphalt in the mix to achieve the desired type of pavement.

Actually, every asphalt pavement requires a special design to provide the best combination of wearing ability and maintenance economy. For this accelerated traffic (30,000 coverages), a mix containing less asphalt was called for, than the 1,500 coverage (prototype traffic) pavement built at Kelly.

The corps then advised the Air Force that it had a new mix designed containing less asphalt, which had withstood 30,000 coverages.

The Air Force did not respond, even though asphalt concrete had shown itself able to withstand the test.

The corps' main consideration in this test was to determine whether it was possible to build a base to withstand this many coverages. The base passed the test.

The surfacing material was not considered to be as important a factor, and explains why the corps originally overlooked the fact that the surface should have been tested for only 1,500 coverages. The asphalt surfacing would unquestionably have passed the Kelly test if the Air Force had:

(*a*) Used 1,500 coverages for the pavement and 5,000 coverages for the base, in accordance with its own 1946 criteria, still in effect, but increased 6 times because of today's greater traffic.

(*b*) Used a lower asphalt content on the test strip, which would have prevented displacement.

For 11 years, since 1946, asphalt pavements have withstood every type of operating condition successfully. But the coverages required in the test were not based on experience—they were theoretical. When the mix was designed for its test purpose, it stood up.

If the severity of a test is increased without reasonable limit as it was for the pavement surface at Kelly, any material or design will show distress.

And so will the taxpayers if good engineering judgment is not used in establishing realistic needs.

The asphalt paving industry sees no reason why asphalt concrete pavements cannot be designed and built to withstand whatever loadings may be called for now or in the future. Asphalt concrete is being improved all of the time—through constant research and development programs.

The designers and constructors of the Kelly test section, say: "Asphalt concrete has withstood actual B–47 operations, can sustain theoretical Kelly test conditions as well."

What really took place at the Kelly test can best be found out from the men who furnished the design and specifications and who built the test section. They are:

Design: W. J. Turnbull, Chief, Soils Division; C. R. Foster, Chief of Flexible Pavement Branch, Soils Division, Waterways Experiment Station, Corps of Engineers, Vicksburg, Miss.

Constructor: Horace S. Kerr, vice president of the H. B. Zachry Co., of San Antonio, Tex.

Commenting on the Kelly test in their joint paper before the second annual convention of the National Bituminous Concrete Association in February 1957, Messrs. Turnbull and Foster said:

"The subgrade, subbase, and the base of the flexible [asphalt concrete] pavement performed satisfactorily and would have withstood 30,000 coverages of traffic.

"Asphalt concrete mixtures designed in accordance with existing criteria are unsatisfactory for immediate use by B–47 aircraft in warm climates if the aircraft is operated as intensively as the accelerated traffic in these tests."

Describing the number of coverages, as excessive, Messrs. Turnbull and Foster's paper says:

"Since channelized traffic was occurring at about 6 times the rate of airfield traffic prior to the advent of the B–47, the existing 5,000 coverages of accelerated traffic as a design requirement was increased to 30,000 coverages as representing the design requirement for channelized B–47 traffic. The design requirement for asphalt paving mixtures of 5,000 coverages of accelerated traffic had been reduced in 1946 to 1,500 coverages in traffic testing because experience had indicated that this amount of accelerated traffic applied in hot weather was sufficient for establishing design criteria for asphalt concrete paving mixtures. Asphaltic-concrete mixtures based on 1,500 coverages of accelerated traffic have successfully withstood prototype B–47 traffic. In the case of the several fields listed above with flexible pavement [asphalt concrete] which have been giving trouble as a result of channelized traffic of B–47 aircraft, no trouble with the asphalt concrete has developed except in one instance where the latter did not meet design requirements."

No one is in a better position to know how unrealistic the test at Kelly was than H. S. Kerr, vice president of the Zachry Co., the man who built the test strip and another Air Force base at Bergstrom, Tex.

"It is my opinion that the severe accelerated concentrated loads applied to the best section do not represent the type of usage that will be applied to the runway pavement at any time during its years of service, and that the asphalt concrete pavement as constructed on the Kelly Field runway will adequately serve any type of aircraft now in use. There is no doubt in my mind but that time will prove this to be true. In other words, I do not think that the test loads and the manner in which they were applied to the test section, represent in any degree the type of loads and methods of application of normal airplane traffic on the runway pavement. Also, these test loads were applied to a newly constructed pavement before it had seasoned.

"An inspection of the asphalt concrete pavement on the runway after 1 year's usage reveals that the pavement is in excellent condition."

Calculations have indicated that it would take as much as 30 months of actual operations to duplicate the accelerated test conditions. And the seasonal changes would allow the pavement to cool off and restore itself during this time.

An interesting example cited by H. K. Griffith, executive director of the National Bituminous Concrete Association, brings out the impossibility of ever encountering anything near 30,000 coverages in operations. He points out that:

"According to recent newspaper reports, the Air Force plans to stop construction of B–52's when the number has reached 600. And all these planes will not be built until 1958. But let's assume that we have the 600 B–52's now and an equal number of B–47's or 1,200 of these planes altogether. If operations came close to the 500 test coverages a day at Kelly, the entire fleet would be landing and taking off 2½ times each day at every one of our SAC bases at the same time—continuously.

"In addition to the impossibility of this ever taking place, how would these planes be serviced? And would the Air Force permit such a concentration of planes in one place because of the perfect target it would make?"

Mr. Griffith continued:

"It's obvious that we are building and paying for much heavier pavements than we require for actual operations. It is advisable to build a substantial foundation, and when it becomes necessary, the surface can be strengthened when and if needed, to accommodate heavier planes or more traffic."

THE AIR FORCE HAS BANNED ASPHALT CONCRETE, BUT STILL BUILDS NEW PAVEMENTS FROM THIS MATERIAL

Air Force bans asphalt, December 20, 1955

After requesting and receiving the Assistant Secretary of Defense's approval to exclude asphalt concrete from primary military pavements, on December 20, 1955, and implementing this new criteria, the Air Force is still using this banned material for new construction, resurfacing, and repairs.

The Air Force complains about asphalt concrete, while asphalt is used, O. K'd and paid for by the Air Force.

Examining both the Air Force's paving policy and its construction activities leaves much to be explained, especially when the dates of various projects are considered.

Air Force builds new asphalt SAC base, November 1956

Eleven months after banning asphalt concrete, a contract for an asphalt concrete runway at a SAC base in Columbus, Miss., was awarded to the R. G. Foster Co. of Wadley, Ga., for the construction of a 300- by 10,000-foot main runway. The asphalt concrete design calls for a 2½-inch binder above which is a layer of 1½-inch asphalt. The runway ends will be of portland cement concrete.

And here are more Air Force contradictions:

January 7, 1957

Gen. Curtis E. LeMay, said:

"* * * We have only two bases which can handle B–52's—at Merced, Calif., and at Limestone, Maine.

Both of these fields have asphalt pavements.

February 1956

Gen. L. B. Washbourne said:

"* * * contractors, by and large, do not produce laboratory-type blacktop pavements on our bases."

He implied that there aren't enough contractors who can build the laboratory-type of material which the Air Force requires. Yet, half of our military pavements are of asphalt concrete and continue to serve under heavy operating conditions.

Perhaps General Washbourne can explain who built these pavements which the Air Force accepted and paid for, and which our aircraft is now using.

If asphalt isn't serviceable, why is it accepted by the Air Force's installations engineers? Isn't someone—either General Washbourne, who flatly condemns all asphalt, or the Air Force's installations engineers who approve it—very wrong?

Air Force bans asphalt, August 1956

Four months prior, in July 1956, an asphalt concrete contract at Dow Air Force Base, Bangor, Maine, was renegotiated to portland cement concrete at almost double the cost. This resulted in an excessive expenditure of $2,964,401.

The Air Force's devices of renegotiating asphalt concrete contracts to portland cement concrete and withdrawing or eliminating asphalt concrete competition from Government contracts are treated in detail in section F.

LACK OF ASPHALT COMPETITION MAKES FOR EXCESSIVE EXPENDITURES IN THE MILLIONS AT AIR FORCE BASE

$124,000,000 saved from February 3, 1954, to December 20, 1955, resulting from the Hess hearings' establishment of free competition in military paving.

$26,000,000 in excessive expenditures, December 20, 1955, to date resulting from the AF's disregard of its agreement with the Hess committee, permitting free competition.

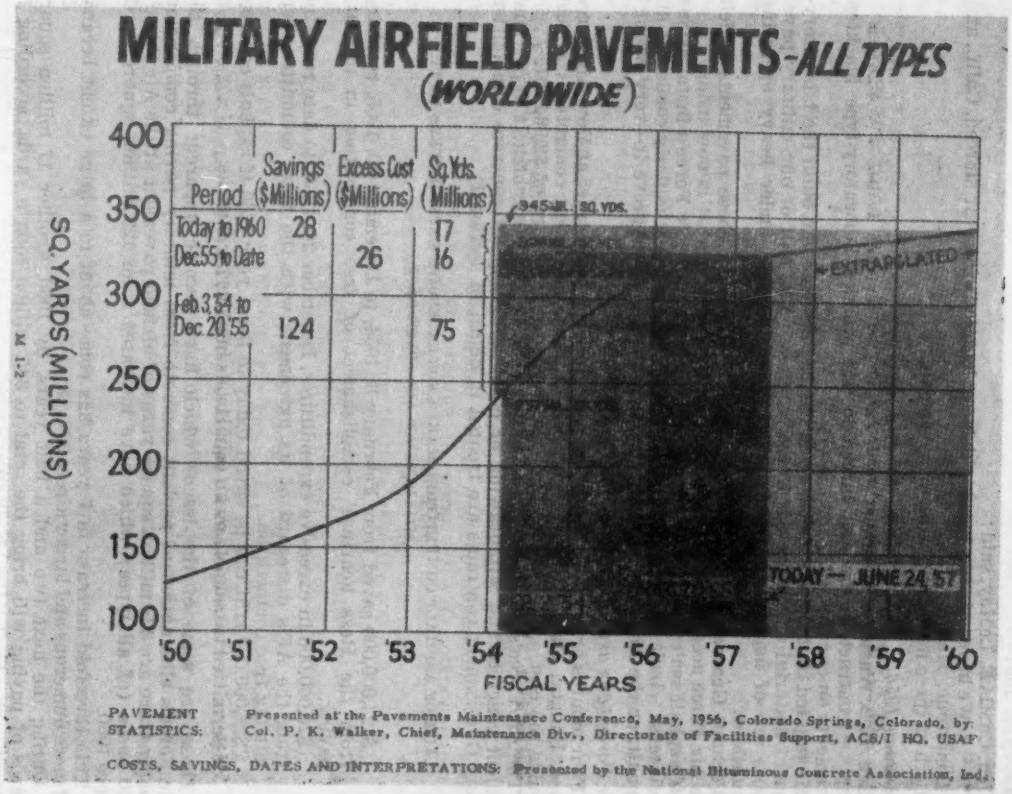
$28,000,000 still can be saved today to fiscal year 1960 if asphalt concrete is permitted to compete on an equal basis in noncritical areas.

These are some of the issues which have become apparent through the Air Force's elimination of asphalt concrete from military paving competition. Today there are 328 million square yards of airfield pavement at the Air Force's 350 bases (of all types) which have increased from 125 million square yards since 1950.

This threefold increase in 7 years has come about to a large extent because of more numerous and larger aircraft.

During the next two and a half years, by 1960, another 17 million square yards of paving will bring the total to 345 million square yards, according to recent figures by Col. Paul K. Walker.

Col. Paul K. Walker, Chief, Maintenance Division, Directorate of Facilities Support, ACS/I HQ USAF, presented these figures at the Pavements Maintenance Conference, Colorado Springs, Colo., May 1956. They are shown in the form of a graph on page M1–2. The statistics he presented have been added to by the National Bituminous Concrete Association, Inc. Included were costs, savings, dates, and interpretations.


MILITARY AIRFIELD PAVEMENTS-ALL TYPES
(WORLDWIDE)
SQ. YARDS (MILLIONS)
400
350
300
250
200
150
100
Period
Savings ($Millions)
Excess Cost ($Millions)
Sq. Yds. (Millions)
Today to 1960 28 17
Dec. '55 to Date 26 16
Feb. 3, '54 to Dec. 20, '55 124 75
345 MIL. SQ. YDS.
EXTRAPOLATED
TODAY — JUNE 24, '57
'50 '51 '52 '53 '54 '55 '56 '57 '58 '59 '60
FISCAL YEARS
PAVEMENT STATISTICS: Presented at the Pavements Maintenance Conference, May, 1956, Colorado Springs, Colorado, by: Col. P. K. Walker, Chief, Maintenance Div., Directorate of Facilities Support, ACS/I HQ. USAF
COSTS, SAVINGS, DATES AND INTERPRETATIONS: Presented by the National Bituminous Concrete Association, Inc.

Although the new construction illustrated on this chart represents between 3 and 4 billion dollars in investments, only a part of the entire picture is revealed. Strengthening, repairs, and replacements of old or damaged pavement constitutes large expenditures which are a part of new construction rather than maintenance.

The proper use of the material is of great importance as there are millions of square yards at many of the Air Force bases. A difference of 2 or 3 dollars per square yard between paving material runs into the millions of extra expenditures at each air base.

Just such a difference in price per square yard of paving material has been explored in detail in section B. According to Earle C. Peck, supervising civil engineer, Technical Training AF: Portland cement costs 88 percent more ($3.29) per square yard than asphalt concrete for heavy duty pavements (p. B1–2).

Engineering calculations by the National Bituminous Concrete Association, Inc., are the source of the figures at the top of the chart, page M1–2. It was assumed that an equal amount of portland cement concrete and asphalt concrete pavements (50–50) were involved in the chart. General Washbourne has revealed that this was approximately the distribution during 1950–55.

Using the chart's statistics, here is how the sums of money were arrived at:

February 3, 1954 to December 20, 1955: 75 million square yards times (50 percent asphalt concrete) at $3.29 per square yard=$124,000,000 saved.

December 20, 1955 to date: 16 million square yards times (50 percent asphalt concrete) at $3.29 per square yard=$26,000,000 excessive expenditure.

Today to 1960: 17 million square yards times (50 percent asphalt concrete) at $3.29 per square yard=$28,000,000 still can be saved.

The cost comparisons of new resurfaced and repaired military pavements at many Air Force bases show clearly that asphalt concrete costs less than portland cement concrete, frequently half as much. These are shown on the following five pages, M1–5 through M1–9.

REFERENCES FOR COST COMPARISON CHARTS

1. Brig. Gen. R. E. L. Eaton's letter of September 2, 1952, to the Honorable Carl Vinson.

2. Earle C. Peck, supervising civil engineer, Headquarters, Technical Training Air Force, presented a paper, "Pavement Problems of Air Training Command," at the Pavements Maintenance Conference May 28, 1956, at Colorado Springs, Colo. His paper dealt with military airfield pavement contracts for the May 1, 1953, to June 30, 1954, period. The information was obtained from the August 1955 Department of Defense special report entitled "Effects of Military Aircraft on Airfield Pavements."

3. Earle C. Peck's reference to the "USAF Pricing Guide" at the Pavements Maintenance Conference.

4. Bernard Gray, the Asphalt Institute's former president, presented price comparisons between new portland cement concrete and asphalt concrete construction for the Plattsburg AFB, N. Y., 1951–54, before the Hess committee (February 3–8, 1954).

5. Byron Schumacher, chief engineer of the Asphalt Paving Co., Coral Gables, Fla. Cost comparisons betwen new portland cement concrete and asphalt concrete construction at Homestead AFB, Dade County, Fla.

6. Smith Engineering & Construction Co., Pensacola, Fla.

7. Scott A. Baker, executive secretary of the Michigan Asphalt Paving Association, Inc., on his May 14, 1957, inspection of the Lockbourne AFB, Ohio, obtained this cost information for pavement resurfacing and strengthening carried out during 1951.

8. A. A. Anderson, chief highway consultant, Portland Cement Association, presented the May 1956 resurfacing costs of the Selfridge AFB, Mount Clemens, Mich., at the Pavements Maintenance Conference.

9. Leslie B. Crowley, Jr., Chief, Pavements and Railroads Section, Maintenance Division; Assistant Chief of Staff, Installations Headquarters, USAF, presented a paper entitled "Engineering Supervision of a Scheduled and Systematized Program for Maintenance and Repair of Pavements," at the Pavements Maintenance Conference. Repair costs of Mountain View AFB, Colo., were included.

10. Charles E. Cobb, president, Jackson Construction Co., Jacksonville, Fla.

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COST COMPARISONS OF NEW CONSTRUCTION

PORTLAND CEMENT CONCRETE VS. ASPHALT CONCRETE FOR MILITARY PAVING

AIR FORCE BASE PAVEMENT TYPES	EXTRA COST FOR PORTLAND CEMENT CONCRETE--	PAVEMENT COST PER SQ. YD. (DOLLARS)
		$0 2 4 6 8 10 12 14
NATIONWIDE, 1952		
ALL PAVEMENTS: (Brig. Gen. R. E. L. Eaton, Ref. 1)		
Portland Cement Concrete	50% Extra	
NATIONWIDE, 1953 - 1954		
HEAVY DUTY: (E. C. Peck, Ref. 2)		
Portland Cement Concrete	88% Extra	$7.05
Asphalt Concrete		$3.76
NATIONWIDE, 1953 - 1954		
LIGHT DUTY: (E. C. Peck, Ref. 2)		
Portland Cement Concrete	60% Extra	$5.26
Asphalt Concrete		$3.30
NATIONWIDE, USAF PRICING GUIDE, 1956		
HEAVY DUTY: (E. C. Peck, Ref. 3)		
Portland Cement Concrete (17")	63% Extra	$10.50
Asphalt Concrete		$6.50
NATIONWIDE, USAF PRICING GUIDE, 1956		
LIGHT DUTY: (E. C. Peck, Ref. 3)		
Portland Cement Concrete (10")	55% Extra	$8.50
Asphalt Concrete		$5.50

COST COMPARISONS OF NEW CONSTRUCTION

PORTLAND CEMENT CONCRETE VS. ASPHALT CONCRETE FOR MILITARY PAVING

AIR FORCE BASE PAVEMENT TYPES	EXTRA COST FOR PORTLAND CEMENT CONCRETE	PAVEMENT COST PER SQ. YD. (DOLLARS) $ 0 2 4 6 8 10 12 14
PLATTSBURG AFB, NEW YORK, 1951-1954		
HEAVY DUTY: (B. Gray, Ref. 4)		
Portland Cement Concrete.....	65% Extra.....	$6.07
Asphalt Concrete		$3.73
HOMESTEAD AFB, FLORIDA, 1951 - 1954		
HEAVY DUTY: (B. Schumacher, Ref. 5)		
Portland Cement Concrete.....	180% Extra.....	$7.00
Asphalt Concrete		$2.50
ELGIN AFB, FLORIDA, 1955		
CHANNELIZED SECTION: (Smith Eng. & Const. Co., Ref. 6)		
Portland Cement Concrete (13").....	134% Extra.....	$7.97
Asphalt Concrete (4")		$3.40
RUNWAY (NON-CHANNELIZED):		
Portland Cement Concrete (12").....	113% Extra.....	$5.75
Asphalt Concrete (4")		$2.70
MAIN TAXIWAY:		
Asphalt Concrete (4")		$3.56
CROSS TAXIWAY:		
Asphalt Concrete (4")		$2.86

COST COMPARISON OF RESURFACING

PORTLAND CEMENT CONCRETE VS. ASPHALT CONCRETE FOR MILITARY PAVING

AIR FORCE BASE PAVEMENT TYPES	EXTRA COST FOR PORTLAND CEMENT CONCRETE	PAVEMENT COST PER SQ. YD. (DOLLARS)
LOCKBOURNE AFB, OHIO, 1951		
HEAVY DUTY: (S. A. Baker, Ref. 7)		
Portland Cement Concrete 11"	90% Extra	$6.86 (av.)
Portland Cement Concrete 12"	(av.)	
Asphalt Concrete (6")		$3.60 (av.)
Asphalt Concrete (7")		
ALEXANDRIA AFB, ALEXANDRIA, LA.		
HEAVY DUTY: 1955		
Portland Cement Concrete (13") (av.).....	83% Extra	$6.10
Asphalt Concrete (4" - 9")		$2.86
SELFRIDGE AFB, MT. CLEMENS, MICH., 1956		
LIGHT DUTY: (A. A. Anderson, Ref. 8)		
Portland Cement Concrete 1" - 1-1/2".....		$3.49

COST COMPARISONS OF REPAIRS

PORTLAND CEMENT CONCRETE VS. ASPHALT CONCRETE FOR MILITARY PAVING

AIR FORCE BASE PAVEMENT TYPES	EXTRA COST FOR PORTLAND CEMENT CONCRETE	PAVEMENT COST PER SQ. YD. (DOLLARS)
		$ 0 2 4 6 8 10 12 14
MOUNTAIN VIEW AFB, COLORADO, 1956		
LIGHT DUTY: (L. B. Crowley, Jr., Ref. 9)		
Portland Cement Concrete.....		——————————————— $14.90
Asphalt Concrete		——— $4.00
PINECASTLE AFB, FLORIDA, 1956		
HEAVY DUTY: (Charles E. Cobb, Ref. 10)		
Asphalt Concrete		—— $1.24

Now, in the interest of saving time for the committee, I will not read my prepared statement, but I ask that it be entered into the record.

I should like to comment on it extemporaneously, very briefly.

(The statement of Mr. Griffith is as follows:)

STATEMENT OF H. K. GRIFFITH

I will try to present to you the highlights of the National Bituminous Concrete Association's fact-gathering efforts over the past year and a half which show the durability, serviceability, and economy of asphalt concrete. The association's members are in accord with the findings of this committee's investigations and conclusions in 1954 where asphalt concrete was limited to noncritical areas.

However, the association's members strongly feel that asphalt concrete is competitive and at least as good as portland cement concrete for runways and taxiways for all types of traffic. The best proof of this is that when portland cement concrete pavements fail repairs are practically always made with asphalt concrete.

A great majority of our pavements are today carrying aircraft which are much heavier than that for which they were designed. The result has been overloading and consequent distress of certain pavements. In this respect, failures of portland cement concrete, as well as asphalt concrete, have taken place and more can be expected to occur. Failures in pavements do not represent dangerous conditions, but rather that repairs are needed.

For the committee's true evaluation of the facts, it is essential that the performance of both pavement types be presented so that true performance can be seen. Only by comparing one type against another is it possible to see the accurate picture. Good as well as bad features and performance of both pavement types are discussed for this reason.

Asphalt-concrete pavements have performed under the most severe military traffic conditions at scores of aircraft bases. To mention a few: Lockbourne, Bergstrom, and Loring Air Force Bases have handled heavier traffic than for which the pavements have been designed. Also, in many cases, asphalt concrete has been serving in critical areas without damage to the pavement—installed before this committee met in 1954.

It is interesting to note that the fears of the Air Force that jet operation would severely impair the readiness of Air Force bases have completely failed to materialize.

By and large, the Air Force relies on asphalt concrete to repair, modernize, and strengthen its existing pavements, whether built of portland cement concrete or asphalt concrete. In spite of paper criteria which banned asphalt, the only practical way to strengthen pavements is by overlaying with asphalt concrete. Damaged or weak pavements are restored to a new condition, which, for all intents and purposes, give assurance of a long service life with little maintenance.

As General Wilson stated last week, asphalt concrete is essential to the Air Force's building and maintenance of bases throughout the world. There are some areas where high-quality aggregates are not available for portland cement concrete and in Arctic regions it is too cold and impractical to build pavements from portland cement concrete. These factors make it essential that continuing progress and research be maintained so that asphalt concrete be improved to withstand the higher loads and greater amounts of traffic which these pavements must sustain.

Also, in time of emergencies, the asphalt industry would be able to restore damaged airports immediately and build new ones.

The presence of the fifteen-hundred-odd asphalt-concrete contractors throughout the United States helps to keep all paving prices down.

Asphalt pavements continue to be built, designed, and accepted by the Air Force's installations engineers and the Corps of Engineers. The reason that these pavements win out on competitive contracts (when they are allowed an even chance to compete) is that a widespread organization of over 1,500 skilled asphalt contractors throughout the United States are equipped to pave airports and highways economically.

Contractors who pave with asphalt concrete are many times more numerous than those who pave with portland cement concrete. The majority of the

1,500 asphalt contractors in the business can best be described as small business, although some of the larger contractors have as many as 1 or 2 dozen individual asphalt plants operating on various jobs.

The asphalt contractors' countrywide distribution and their mobility brings bidders out for Government work in large numbers, resulting in the lowest paving cost.

The chart of asphalt contractors by States shows their widespread distribution.

Asphalt concrete's economy showed up clearly under our competitive-bidding system until banned in December 1955. Frequently the economics are as high as 20 to 50 percent of the total cost and at Homestead AFB, they were 300 percent.

Time and time again it has been demonstrated that if options are permitted on Government bids, many more contractors bid, and the cost is less. On airfield paving contracts this amounts to considerable sums of money, running into the millions on each airport. The facts are clear—brought out by the United States Air Force's Earl C. Peck, supervising civil engineer. For heavy duty pavements (the type mostly being built by the Air Force) portland cement costs 88 percent more ($3.29 per square yard) than asphalt concrete. These figures apply for the May 1, 1953, to June 30, 1954, period. More recent costs based on the latest USAF Pricing Guide show savings of $4 per square yard for asphalt concrete.

Last week, General Wilson cited costs of $6.89 to $3.67 for portland cement concrete and asphalt concrete. Portland cement costs 88 percent more ($3.22 per square yard) than asphalt concrete.

When it comes to repairing and strengthening old pavements, asphalt concrete's economics and advantages are truly impressive.

It is impossible to keep surfaces from wearing and new aircraft impose heavier loads upon the pavements than they were originally built to stand, making modernization mandatory.

As an example, today's gear loads are 100,000 pounds for B–47's and 240,000 pounds for B–52's, compared to only 15,000 pounds in 1946. This is an increase of about 16 times. Resurfacing and strengthening with asphalt concrete is the most economical, fastest and most practical way of modernizing pavements. The only other alternative is to either remove and replace the old portland cement concrete with a new slab, or to place a second portland concrete slab over the old. Frequently, this overlay is as thick as the original pavement and costs as much.

Not so with asphalt concrete. The cost is very small for resurfacing an old pavement—just a fraction of the new one. What is even more important is that the new surface is as good as a new pavement would be if built from the ground up, when properly designed and constructed.

The difference in repair costs by each of the two methods is vividly demonstrated by noting the price of repairing both types of pavement at the Mountain View Air Force Base, Colo. This is shown on the chart. Replacing and repairing 8,473 square yards of overloaded portland cement concrete pavement cost $126,300—an average cost of $14.90 per square yard. Compare these costs with asphalt concrete repairs at the same base. The 134 square yards which had to be repaired for reasons other than pavement difficulties, such as inadequate drainage, came to $550—an average cost of only $4.08 per square yard. It costs almost four times as much to restore the portland cement concrete as it cost to restore the asphalt concrete at this base.

One of the frequently referred to costs are maintenance costs. Capt. G. C. Bill of United States Navy brought out that the cost of maintaining either of the two pavements is about the same because of the continuing joint filling cost on portland cement concrete. On the other hand, there are many bases which have asphalt concrete in service, such as Bergstrom where no maintenance has been required for a period of over 4 years. Cost records for either material are not readily available to show the exact maintenance cost of each but it is apparent that portland cement concrete requires considerable maintenance, notable for joint filling and repairing of spalled surfaces, particularly around the expansion joints and the reaction of chemicals used in de-icing.

The Air Force's paving policy is contradictory. Officially, the Air Force has banned asphalt concrete. But pavements of this material continue to be built, used, okeyed, paid for, and accepted by the Air Force.

One outstanding example is shown at a SAC base in Columbus, Miss., where a 10,000-foot-asphalt-concrete runway is now under construction.

Because the Air Force has not abided by its agreement with this committee in allowing free competition for asphalt concrete paving, additional expenditures have resulted. Although it is not possible to pinpoint all of them, a few are mentioned here. An item-by-item tally at only 8 AF bases amounts to $6,830,081. The excessive expenditures which took place from December 20 until today are estimated at $26 million. Specifically, these overexpenditures came about by 3 Air Force devices of eliminating asphalt concrete competition from Government paving contracts.

Device No. 1.—Asphalt concrete low bids were renegotiated and portland cement concrete substituted at a higher price. At Dow Air Force Base, this came to $2,964,401. At Grand Forks Air Force Base, this came to $474,878, and at Alexandria Air Force Base $324,270 was involved.

Device No. 2.—Asphalt concrete options were withdrawn from bids which had already been advertised. Overexpenditures at 3 Air Force bases are shown. At George Air Force Base, there was an overexpenditure of $50,000; at Davis-Monthan Air Force Base, an overexpenditure of $185,000, and at Gieger Air Force Base, an overexpenditure of $201,532.

Device No. 3.—Asphalt concrete options were completely omitted from bids. At 2 bases the amounts were $2,500,000 at Sheppard Air Force Base and $130,000 at Davis Air Force Base.

Personal feelings, rather than engineering facts or operational requirements seem to have determined the Air Force's preference for portland cement concrete.

Erroneous impressions have been picked up in the press as a result of these blanket condemnations of asphalt concrete by the Air Force. The impression that only asphalt fails is obviously inaccurate in light of General Washbourne's statement at the pavements maintenance conference in May 1956, "You will be confronted with spalling, broken slabs, base failures, and similar problems for a long time to come."

A few months earlier, in February 1956 at the meeting of the Associated General Contractors, General Washbourne said:

"Concrete (portland cement) can take it; blacktop can't." But as we said before, the truth of the matter is that all pavements have difficulties and it is not fair to the American public who pays taxes for high-cost pavements, or to the United States Government, or the asphalt industry, to blame asphalt for all pavement difficulties.

Asphalt concrete has withstood heavy jet aircraft operation, as well as Air Force criticisms.

Several investigations by the Corps of Engineers, the Navy, the Highway Research Board, and the Air Force installations engineers have approved this material for new construction, repair, and strengthening of old pavements.

Where difficulties have been experienced with flexible pavements, specific causes such as poor design or construction were found to be the reasons. Failure of the subgrade or compaction in the subgrade were the actual or contributing factor in many of the failures.

The Highway Research Board, at the request of the Department of Defense, appointed a committee of pavement specialists to study the effects of aircraft operation on military airfield pavements. This committee, composed of engineers eminent in their particular fields, conducted a study at 27 Navy, Marine, and Air bases within the United States. The committee found that asphalt concrete was serviceable and durable in noncritical areas.

The Air Force's complaints about asphalt are the reasons given for banning this material for pavements. The complaints fall into three categories:

I. Pavement failures.
II. Uneven surfaces.
III. Loose particles.

Let's examine the facts:

Air Force complaint No. 1: Pavement failures from all cases

Every alleged asphalt failure made public was traced to other factors.

Investigating groups included the Air Force itself, the Corps of Engineers, the Highway Research Board, the Asphalt Institute, and consulting engineers.

Yes, there were difficulties—but from other causes. The fault was traced to poor design, poor construction, poor maintenance, and poor coordination between aircraft research and design; and pavement construction.

Air Force complaint No. 2: Uneven pavement surfaces

Bouncing (porpoising) of aircraft has been blamed entirely on asphalt pavements by the Air Force. Investigation has revealed that this also happens on portland cement concrete pavements.

The Air Force proposed to eliminate this bouncing, so dangerous to crew and planes, by specifying "absolutely smooth pavements." These requirements were met by asphalt contractors. Then suddenly, on March 13, 1957, the Air Force relaxed its requirements.

Why?

Isn't bouncing dangerous any more?

The Corps of Engineers, South Pacific division, conducted a grade control conference in San Francisco, Calif., on January 25, 1956, to deal with this problem. Attended by the corps, the Air Force, the Asphalt Institute, and leading engineers and contractors, the problem and possible remedies were discussed. It was clearly indicated that aircraft bounced on all pavements, and that many factors are involved in addition to pavements.

Air Force complaint No. 3: Loose particles from broken pavements

Jet engine damage from loose particles has been blamed entirely by the Air Force on asphalt pavements.

The recent Department of Air Force appropriations hearings (in May 1957) indicate that damaged portland cement concrete pavements are responsible in a large measure for jet engine damage.

The National Advisory Committee for Aeronautics found that loose particles from portland cement concrete pavements were sucked into jet planes more readily than from asphalt pavements. These findings, based on research, revealed that particles lodged in portland cement concrete joints are blasted up as high as 8 feet and sucked into jet engines. Particles move sideways on smooth asphalt surfaces, and not up.

Pavement criteria changes came faster than new aircraft models since the latter part of 1955. The major criteria changes are demonstrated by using Pinecastle Air Force Base, Orlando, Fla., as an example. Following the February 3, 1954, hearings this committee designed critical areas where portland cement concrete was considered desirable (runway ends, blast pads, fueling aprons, wash racks, etc.). All other areas, such as primary runways and taxiways, were considered as being equally well served by either type of pavement. The critical areas are shown by the shaded areas on the chart.

On May 3, 1955, the Corps of Engineers issued an interim criteria for channelized traffic. This criteria required heavier pavement design in areas of channelized traffic. This is shown by the dotted line on the taxiways connecting primary runways and fueling aprons.

The Air Force, December 20, 1955, criteria specified all portland cement concrete for all primary runways and taxiways.

Let us stop and consider what this means in additional paving costs if only portland cement concrete had been used on this base. Mr. Peck's or General Wilson's price differential is $3.29 or $3.22 per square yard between the two materials. All areas shown are approximate. There are 542,000 square yards of runway pavement (excluding critical areas). The extra cost for this amounts to $1,780,000. On taxiways there are 152,000 square yards. This amounts to an extra $500,000. The runways and taxiways together would cost an extra $1,932,000 if asphalt concrete had been eliminated from competitive bidding when this base was built in 1954.

Here, gentlemen, we have almost $2 million at one base which was saved as a result of competitive bidding—a common procedure until the Air Force adopted its one-material policy.

General Wilson has said that only 16 asphalt-built bases required some kind of repair from channelized traffic. How much does this amount to? Consider the cost of a few million for the use of portland cement concrete at each base against the small repair costs which may be needed from time to time for repairing taxiways damaged by channelized traffic. And let us also remember that portland cement concrete taxiways also suffer from this same difficulty.

The $3.29 extra per square yards adds up to tremendous sums when one considers the 350 bases in the Air Force base operation. Here is what this $3.29 difference between the 2 paving materials means:

> $124,060,000 was saved as a result of the Hess hearings' establishment of free competition in military paving from February 3, 1954, to December 20, 1955.

$26,000,000 in excessive expenditures resulted from the Air Force's disregard of its agreement with the Hess Committee, permitting free competition from December 20, 1955, to date.

$28,000,000 still can be saved if asphalt concrete is permitted to compete on an equal basis in noncritical areas from now until fiscal year 1960.

Although the new construction illustrated on this chart represents between three and four billion dollars in investments, only a part of the entire picture is revealed. Strengthening, repairs, and replacements of old or damaged pavements constitute large expenditures which are a part of new construction rather than maintenance not shown here.

Engineering calculations by the National Bituminous Concrete Association, Inc., are the source of these approximations. It was assumed that an equal amount of portland cement concrete and asphalt concrete pavements (50–50) were involved in the chart. General Washbourne has revealed that this was approximately the distribution during 1950–55.

Using the chart's statistics, here is how the sums of money were arrived at:

February 3, 1954, to December 20, 1955: 75 million square yards times (50 percent asphalt concrete) at $3.29 per square yard, $124 million saved.

December 20, 1955 to date: 16 million square yards times (50 percent asphalt concrete) at $3.29 per square yard, $26 million excessive expenditure.

Today to 1960: 17 million square yards times (50 percent asphalt concrete) at $3.29 per square yard, $28 million still can be saved.

The cost comparisons of new, resurfaced, and repaired military pavements at many Air Force bases show clearly that asphalt concrete costs less than portland cement concrete, frequently half as much. These are shown on pages M1–1 to M1–10, of the National Bituminous Concrete Association, Inc.'s, presentation entitled "Facts Show Asphalt Can Take It."

Mr. GRIFFITH. We feel that the Corps of Engineers in its testimony presented here during these hearings has done a magnificent job in boring to the heart of the problem facing us, and that their forthright testimony and straightforward answers are to be commended.

We have the utmost confidence in the corps' ability to solve the problems facing us now, and future problems that may arise, if they are provided adequate funds to continue their research and testing as was developed by their own witnesses during these hearings.

I refer specifically to the testimony of Mr. Foster, in which he pointed out that last year, fiscal 1957, they had had $400,000 for experimental work which was less than was intended and now they have a program presented to the Air Force that will cover a period of 4 years in which they request $800,000 a year.

There is a great deal of testimony on that question, and I urge you to give it serious consideration.

They also testified that had they been able to continue their test now in progress, they perhaps would have been able to give you the answers that you were seeking as to the ability of asphalt to meet the requirement for channelized traffic on these heavy bomber bases. I would like to point out, too, that they did say that they were almost at the conclusion of those tests and that within a very short time the results would be known.

We believe in a very short time the results would be known.

We believe that they will prove without question that asphalt can do that job, of meeting the requirements of channelized traffic.

We also believe that in a reasonable length of time they will be able to give you the answer which will be favorable to the tests that they propose to conduct for the 325,000 pound gear loading.

This committee in its wisdom established a design criteria during its 1954 hearings that dealt with the then known problems.

That was damage from jet blast and fuel spillage. While we felt that there was overemphasis perhaps—and this is an opinion—placed on the severity of the damage from these two causes, nevertheless, we recognized it was a problem and we accept without qualification the committee's decision and recommendation as to the critical areas.

You want to display the chart [addressing Mr. Schwartz]?

Now then, through the mass of testimony heard by the committee, we come to another problem.

That is an outline of the Pinecastle Air Force Base, Orlando, Fla., showing parallel runways, taxiways, aprons, and so forth.

The shaded parts depict the so-called critical areas, as pointed out by this committee, and recommended that the Air Force use portland cement concrete to alleviate the blast damage and the fuel spillage. Now, it is only recently that another problem was developed, as it was pinpointed here in the earlier testimony, and that is of channelized traffic.

The Corps of Engineers on May 3, 1955, recognized the channelized traffic problem. This overlay points out the restricted areas where channelized traffis is now a problem. You will note the dotted lines through the runways on the 500-foot ends—the dotted lines through the taxiways, the 500-foot ends of the runway, and through parts of the aprons.

Now, that is really the hub of this whole matter. That is the whole problem, of what to do about the channelized sections. There is really no other problem.

It has been established by the Corps of Engineers that either type of pavement would successfully perform in these so-called areas, and that that they feel they are on the verge of a breakthrough to the point where they can say without question that they can build an asphalt pavement that will meet the needs of the Air Force for channelized traffic, the 52's. They haven't reached the point, yet. Their safety factor is so high—and we commend them for taking that position.

But in a matter of weeks, we believe they will be able to give a positive answer.

Now, I would like to point out, on the taxiways, that channelized area only comprises one-third of the overall area of the taxiway.

It is also in the 500 feet of the runway ends that are already considered critical.

So the real problem that we now have is that of channelization.

Now, General Wilson, in his testimony, on page 236, pointed out that since 1952, a certain number of square yards of asphalt pavement had been built on 105 airbases throughout the United States, and overseas. In 10 of the 13 heavy-load pavements which showed distress, the problem was confined to areas subjected to channelized traffic. The other two were on light-duty airfields. This presents a condition of overuse by producing approximately six times the number of load repetitions assumed in the design prior to 1954, which in effect admitted the areas in which that damage occurred were not designed to meet this special problem.

In fact, he goes on to say that deficient design and construction was primarily the cause of distress in the other four cases investi-

gated. That is the difference between the 13 and the 16 or 17 bases that he had reference to.

I would like to point out further that in his testimony he said in June 1955 a new design criteria was prepared by providing for the channelized traffic of B–47's. In March 1956 similar criteria for the channelized traffic and increased loadings of the B–52 were assumed.

Now, in that change in criteria of June 1955 for channelized B–47 traffic, it was pointed out, or it is pointed out, that that change in criteria was not confined to rigid pavements alone. It was confined to both types of pavements.

Even the Air Force in its existing design criteria provides for channelization only on the 500-foot ends of the runway.

So in effect, the interior portion, the 10,000 feet by 300 feet width of runway, is not a problem subjected to channelized traffic. That leads us to another point which is most important to all of us, and that of economy. Our contractors do not feel our financial duty can be mortgaged by the elimination from competition of asphalt concrete pavements.

It has been repeatedly pointed out to you that there is a very definite economic advantage between the two types of pavement, and also the fact that competitive bidding does provide even closer competition which results in benefits to the Government.

Now, I would like to use another chart to point out our estimates of savings that have occurred and excessive expenditures that have occurred and savings that may be made over the next 2 years.

We have here a chart showing square yards of airfield pavement for the various years.

The source of this information is a document called Report of Pavement Maintenance Conference, held at Colorado Springs by the Air Force.

Mr. COURTNEY. We have a copy of those proceedings in the committee files, Mr. Chairman.

Mr. GRIFFITH. You have a copy, Mr. Chairman.

From February 3, 1954, to December 20, 1955, there was approximately 75 million square yards of airfield pavement constructed.

Now, using the figures of Mr. Peck—and the reference is contained in my prepared statement, who is a civil employee of the Air Force—or the cost differential as pointed up by General Wilson, and the statement of General Washbourne in previous hearings, not necessarily before this committee but other committees, where he said that approximately half of each type pavement was used—as a result of this committee's hearings in 1954, and the accepted critical areas as defined by you, this Government saved $124 million.

Now, with the coming of the new criteria, which practically eliminated asphalt concrete from competition, December 1955 to today, there has been approximately 16 million square yards of additional pavement built.

Now, if we assume that half of that yardage would normally have gone to flexible pavement if it would have been permitted to compete, and using the same price differential, then there has been $26 million in excessive expenditures.

Now, let's look at the future.

We have extrapolated the yardage figures taken from the document I mentioned.

There appears to be still 17 million square yards of new pavement to be constructed, using the same figures, there can still be $28 million saved if our contractors are permitted to build competitively.

The next chart. On this chart, is a map of the United States, with the States outlined, showing the number of contractors who are equipped to bid on airfield paving work, that is asphalt work.

You will notice that there is a very fair distribution, with the exceptions of maybe some of the west central portion of the country.

Nevertheless, these contractors are not bound by State boundaries. They move around. The fact is that not only have they not been permitted to bid on the SAC bases where this channelized traffic occurs, but they have not been permitted to bid on even National Guard bases, that is Reserve bases, as well as air command defense bases, and all those bases where the light wheel loads are required.

Now, again, I return to the testimony of General Wilson, when I say, when I repeat that he pointed out that both types of pavement were absolutely necessary to the Air Force.

One of the reasons he gave was because it was more practical to use it in the colder climates, and in areas where certain aggregates were not available for use with portland cement concrete.

But are we to choke off the industry and all this other vast area, and if we do will we be able to perfect our techniques, continue our work, and be able to serve this Government in time of real need? Which we are, as you can see, prepared to do.

The flexibility that our organization has with reference to moving in and moving out and getting a job done, whether it is under pressure or normal procedure, and the adaptability of lower type aggregates to use in asphalt cement is well known to the entire industry. Therefore, we feel this committee will in its wisdom arrive at some equitable solution to the problem.

Mr. HÉBERT. Mr. Griffith, you have heard a great deal of discussion about the Kelly tests. Was your association in possession of any knowledge that the test was to be conducted?

Mr. GRIFFITH. Yes, sir, Mr. Hébert, we did know about it indirectly.

Mr. HÉBERT. You were never informed formally or officially?

Mr. GRIFFITH. No, sir, not until after the completion of the test.

Mr. HÉBERT. What did you do after the completion of the test?

Mr. GRIFFITH. If I may be able to narrate, I will point up step by step what happened.

As you know our group is relatively new, or was at the time the Kelly test was in progress. We heard about it because a member of our association was at that time engaged in building—rather doing construction on Kelly Field proper. And his firm, the H. B. Zachry Co. did build the test portion—both the flexible and the rigid portions.

We kept in contact with the progress of that test through our members. When it began to show distress, we knew about it. And in a relatively short time, as you all know, the test was discontinued.

We recognized the importance of that test and what it might do to our industry, what it might lead to, how the implications could carry over—and I might say they have carried over—into other paving fields, such as the paving of civil airports and the highway field.

We called a meeting of all our contractors who are familiar with airfield construction, especially those from the Southwest, in San

Antonio, Tex. At that time the test had been discontinued. We were permitted to visit and observe it. We spent one morning there.

After we had had an opportunity to look over it and talk to the engineer in charge, we held a meeting in a hotel in San Antonio, Tex., to talk among ourselves and express our opinions as to what had happened.

Now, I will give you these expressions as we got them from our members—these practical fellows who do this work all the time.

There was considerable speculation as to the mix design, the gradation of the aggregate, the type of asphalt used. It, incidentally, is known to the trade as a tender type asphalt, one that doesn't set up quite as quickly as another type. There was considerable speculation as to the use of an additive, known to us as a liquid that is put into the asphalt to permit it to coat faster, to coat wet stone, et cetera.

But the general theme revolved around the fact that there was an accelerated test under high temperatures and in no way reflecting a true test, that is, insofar as to the performance of that pavement under normal operating conditions.

Now, those are opinions as expressed by our people. After that meeting I was instructed to go to Vicksburg and visit Mr. Turnbull and Mr. Foster, in an attempt to determine what had happened. What in their opinion was the cause.

I did that. I might say I was very graciously received and given every bit of information they had. And they concurred, that is, we concur in their findings. They felt, first, that there was too much asphalt used in the pavement, in the mixture, and maybe 2 or 3 other minor things that are of no consequence.

We offered at our expense to replace the damaged pavement at no cost to the Government, if the test would be continued, using a different type of mix.

When I was in Vicksburg, Mr. Turnbull advised me—when I made him that proposition—that he understood that there had been a conference held at Kelly Air Field, at which time it was decided to discontinue the test.

Of course, we still were interested in what happened. And the same contractor who built it originally—and this may clear up some questions that came along through the hearing—was requested to furnish a price of removing the whole thickness, 5 inches—now, understand, the base had not been disturbed. It showed no sign of distress. The distress was in the upper layers.

This contractor was asked to furnish an estimate on the cost of removing the whole 5 inches and replacing it. He did that.

It was felt, according to the contractor, that that cost was excessive and he was asked for another price or quotation on removing only that portion on the top that had deformed or rutted. He gave them a price on that and was permitted to proceed.

What he did, according to his letter in my files, and it can be made a part of the record if you so desire.

Mr. COURTNEY. I think it should be, Mr. Chairman.

Mr. HÉBERT. I believe it should be made a part of the record.

Mr. GRIFFITH. I believe it is referred to in the book. It has that reference.

Mr. HÉBERT. I would like to have that letter in the record.

Mr. GRIFFITH. All right, sir, we will provide it.

He removed the asphalt, the upper layer of the asphalt, approximately three-quarters to an inch in depth, with a maintainer or as you would know it, a grader, for approximately 12 feet in width. Remember, this channelized test was confined to 7 1/10 feet in width, down the center.

That was replaced with a mix similar to that used for the major paving on Kelly Field, and it is now in use today.

Mr. HÉBERT. You replaced it with asphalt, or the flexible?

Mr. GRIFFITH. He replaced the asphalt surfacing material that had been removed, approximately three-quarters to an inch. That is just what he bladed off with the grader. Twelve feet wide for the length of this test section. And he replaced that with asphalt concrete, with a mix design. It may have been exactly or at least was similar to the mix that he had been placing on the runway, the taxiways and other areas at Kelly Field.

Mr. HESS. But it was a different mix than the one originally put on there?

Mr. GRIFFITH. Yes, sir.

Mr. BROOKS. More rigid?

Mr. GRIFFITH. Well, no, we can't refer to asphalt pavements as being rigid.

Mr. BROOKS. Less flexible.

Mr. GRIFFITH. It was a mix better designed to meet the normal needs to which it would be subjected.

Mr. HÉBERT. That has shown no distress as of now, to your knowledge?

Mr. GRIFFITH. So far as we know, there is no distress. If it has occurred, it has occurred in the past few weeks.

Mr. HESS. You are referring now to this second mix that was used to repair this runway on which the test was performed and you say that it was a similar mix to the one used on the balance of the runway as on Kelly Field?

Mr. GRIFFITH. Yes, sir.

Mr. HESS. When were those runways put down?

Mr. GRIFFITH. They were——

Mr. HESS. Prior to this test or after?

Mr. GRIFFITH. Some of them had been put down prior to the test and some of them were being put down.

Mr. HESS. All right.

Mr. GRIFFITH. That was the reason the firm built the test section; he had a contract on the field.

Mr. HESS. Why was there a different mix used on the test section, then, than on the field that was being built?

Mr. GRIFFITH. Mr. Hess, that would have to be answered by the Corps of Engineers.

Mr. HESS. But you know that is the fact?

Mr. GRIFFITH. Yes, sir.

Mr. HÉBERT. What happened to your offer to construct this section that was in distress?

Mr. GRIFFITH. So far as I know, it died there.

Mr. HÉBERT. With the engineers?

Mr. GRIFFITH. With Mr. Turnbull and Mr. Foster. Because I was informed that the decision had already been made to discontinue the testing.

Mr. HÉBERT. The thing that I want to get clear in the record is: The engineers, as I understood their testimony, were merely the agents of the Air Force in conducting the test?

Mr. GRIFFITH. We were told that; yes, sir.

Mr. HÉBERT. The decision rested with the Air Force?

Mr. GRIFFITH. We were told that; yes.

Mr. HÉBERT. Then, if a rejection was given to your offer, it came through the engineers merely as the agent of the Air Force, which made the decision.

Mr. GRIFFITH. Yes, sir.

Mr. HÉBERT. Would that be your understanding?

Mr. GRIFFITH. So far as we understand.

Mr. HÉBERT. That is right. We will clear it up and have the Air Force back. I wanted to get that for the record. In other words, the Air Force refused to allow you to explore further these tests, at your own cost?

Mr. GRIFFITH. I want to make it perfectly clear that we did not make this offer to the Air Force.

Mr. HÈBERT. No, but you made it to the agent of the Air Force.

Mr. GRIFFITH. That is right; yes, sir.

Mr. HÉBERT. And you were presuming, and logically so, that the offer was relayed to the Air Force, who was the principal, and was denied by the Air Force?

Mr. GRIFFITH. Mr. Hébert, I can't say positively, but it is my opinion that because of the fact that the decision had been made to discontinue the testing, that the offer was not relayed to the Air Force. I don't know, but that is my——

Mr. HÉBERT. Don't you think you should have gone to the Air Force directly, on a subject so important?

Mr. GRIFFITH. Perhaps we were remiss, yes, sir. However, we were dealing with the engineers who had designed and conducted the experiment.

Mr. HÉBERT. Anything further, Mr. Hess?

Mr. HESS. No.

Mr. HÉBERT. Any questions, Mr. Bates?

Mr. BATES. It is 12 o'clock. Will we be back?

Mr. HÉBERT. We are trying to finish now.

Mr. BATES. All right. Mr. Griffith, I am not certain from reading your statement whether you indicate there is as much porpoising on concrete as there is on asphalt.

Mr. GRIFFITH. Pardon?

Mr. BATES. I say I am not certain from reading your own statement here, which you entered into the record but which you did not read, whether you contend there is as much porpoising—bouncing as you phrase it—on portland cement pavements as there is on asphalt.

Mr. GRIFFITH. What page is that on, Mr. Bates?

Mr. BATES. Page 10.

Mr. GRIFFITH. We say:

Bouncing or porpoising of aircraft has been blamed entirely on asphalt pavements by the Air Force. Investigation has revealed that this also happens on portland cement concrete pavements.

Now, our authority for that statement is a meeting of the Corps of Engineers, South Pacific division, conducted on grade-control conference at San Francisco, on January 25, 1956, to deal with the problem.

Now, at this conference the Corps of Engineers was represented, the Air Force, the Asphalt Institute, and many engineers and contractors.

Mr. BATES. Yes. You don't have any firsthand information yourself? I didn't know, from reading your statement, whether it bounces more or less on one or the other.

Mr. GRIFFITH. Well——

Mr. BATES. What is your position on that?

Mr. GRIFFITH. No; we don't say the bouncing is confined to any particular type of surface; no, sir.

Mr. BATES. I understand that.

Mr. GRIFFITH. It is in both.

Mr. BATES. You say it bounces on both?

Mr. GRIFFITH. Yes, sir.

Mr. BATES. But does it bounce more on one than on the other?

Mr. GRIFFITH. I don't believe anybody could say that it bounces higher on one type than on another type. I doubt very much if there are statistics that would prove it. I certainly wouldn't say it; no, sir.

Mr. BATES. So far as you know, there is no essential difference?

Mr. GRIFFITH. That is right.

Mr. BATES. Now, on Air Force complaint No. 3, concerning the loose particles, I see you indicate that the portland cement pieces bounce upward but the one from asphalt go sideways. I wish you would explain that to me.

Mr. GRIFFITH. Yes, sir. And that, too, was taken from information presented at this same grade-control conference. And source is the National Advisory Committee for Aeronautics. They found that loose particles from portland cement concrete pavements were sucked into jetplanes more readily than from asphalt pavement. These findings based on research revealed that particles lodged in cement, portland cement joints—and, as you well know, all portland cement concrete has joints at certain intervals. That is what I have reference to. This committee found that those spalls lodged in those joints and, when they were blasted, subjected to blast, they flew up high and were sucked in, whereas spalls that do occur on asphalt pavements as well, that is, loose particles, were not prone to be wedged or lodged in construction joints. Consequently, when the blast hit them they spread out. Now, this is not ours. We are merely quoting the information.

Mr. BATES. I see. You don't have any firsthand information yourself?

Mr. GRIFFITH. No, sir.

Mr. BATES. Except that which you quoted?

Mr. GRIFFITH. As I say, we are using these sources.

Mr. BATES. That is in the event there are loose particles.

Mr. GRIFFITH. Yes, sir.

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Mr. BATES. If both runways are in good condition, you wouldn't have the loose particles; is that correct?

Mr. GRIFFITH. If they were in perfect condition, we would not have those loose particles.

Mr. BATES. Well, in the normal course of events, would you expect a greater frequency of loose particles on asphalt than you would on concrete, or vice versa?

Mr. GRIFFITH. Not a properly designed asphalt pavement; no, sir; no more.

Mr. BATES. You don't think, if both of them were properly designed, there would be any essential difference?

Mr. GRIFFITH. No, sir.

Mr. BATES. That is all I have.

Mr. COURTNEY. Mr. Chairman, we have the statements of the gentlemen referred to by Mr. Hays, whose names I shall read, and I would ask their statements be made a part of the record today. Mr. John W. Kelly, who is a partner in the Imperial Paving Co., of Oklahoma City. His statement refers principally to Tinker Air Force Base and some other professional comment. Mr. Al Kavanaugh, the president of the Metropolitan Paving Co., of Oklahoma City. Mr. H. S. Kerr, who is vice president of the H. B. Zachry Co., of San Antonio, Tex, which company has been referred to previously. Mr. Schuyler B. Hudson, who is an employee of the firm of Miller-Warden Associates, of Swarthmore, Pa., who have had some considerable experience in this field. And Mr. Warren B. Warden, owner and manager of this same firm. Their principal offices are in Raymondville, Mo., and Chicago, Ill.

Mr. HÉBERT. They will all be made part of the record at this point.

(The statements referred to follow:)

STATEMENT OF JOHN W. KELLY, PARTNER, IMPERIAL PAVING CO., OKLAHOMA CITY, OKLA.

I am a partner and general manager of the Imperial Paving Co., of Oklahoma City, Okla., and a registered professional engineer. Before that, I held the position of materials and paving engineer for the Tulsa District of the Corps of Engineers.

Our company had the contract for construction of a major airfield paving contract at Tinker Air Force Base. This project was constructed under the design criteria of 1954, which called for the warmup aprons and 1,000 feet of each end of the runway to be constructed of rigid portland cement concrete. The balance of the project was constructed of flexible pavement, using bituminous concrete on the surface. The major part of this contract, namely the north-south runway, was completed and placed in operation during the fall of 1955.

During the construction of this project, we were subjected to considerable criticism and abuse by the newspaper and national trade magazines on the basis of news releases and statements by the Air Force stating that asphaltic concrete had failed on this project.

We were at a loss to understand the statements, and tried to trace the source of information and the exact nature of the so-called failure. These alleged failures were reported while the project was still under construction, during 1955, and many months before any part of the project was turned over to the Air Force for their use.

We subsequently learned that a B–47-type airplane, for some unexplained reason, went through a barrier and over a temporarily incompleted portion of the project, causing tire marks in the subbase and a slight deformation. This area was scheduled to be reworked as part of the overall construction plan, and was closed to Air Force aircraft. The area had been barricaded and was not supposed

to be used. The area was an overlay of an existing 7-inch, rigid, portland cement concrete slab which had failed under all kinds of traffic and was in the process of being salvaged. It had been built in 1942.

The district engineer commented, when he awarded us the Corps of Engineers annual safety award, "this was, in his opinion, not only the safest project, but also the best airfield paving that had been constructed in the Tulsa district."

Let me review some of the construction figures on this project:

1. The warmup aprons and 1,000 feet on each end of the runway were constructed of rigid portland cement concrete at an average cost of $7.35 per square yard.

2. The taxiway and interior 10,000 linear feet of the runway were constructed of flexible bituminous concrete at an average cost of $3.91 per square yard.

3. The north 5,000 feet of the north-south runway was constructed by overlaying an existing failed rigid portland cement concrete slab. The balance of the project was all new construction. This consists of 6,000 feet of a stabilized stone base with 4-inch asphalt concrete surfacing and a 1,000-foot portland cement concrete end at the south of the runway.

4. The new runway has now been used for approximately 150,000 operational flights of all types, varying from piston-type aircraft to B–52 bombers and Century-type fighters.

On May 6, 1957, I had an opportunity to make a detailed inspection of the runways and taxiways at Tinker Air Force Base. This inspection was made in company with Mr. J. Rogers Martin, engineer for the Asphaltic Concrete Association of Oklahoma. Mr. W. L. Foster, Chief Engineer of the Air Installation Section, arranged for our inspection.

We found both the flexible and rigid sections of 100 percent new construction to be in excellent condition. There was no evidence of rutting, shoving, raveling, or cracking. The high-speed riding conditions in a short wheelbase vehicle were exceptionally good on the flexible section and fair on the rigid section.

The north section of the runway end was showing considerable distress. It was cracking, spalling, and the joints were failing. The majority of the joints were breaking back away from the joint line and spalling out in pieces from ⅛ to ½ inch in size. When the old portland cement concrete was overlaid by a 14-inch slab, no provision for drainage of the subbase had been made and none of the broken portland cement concrete slab had been removed.

The 4,000-foot portion just south of the runway end was also showing signs of distress. Ten inches of stabilized aggregate base covered with four inches of asphalt concrete had been placed over a broken and cracked portland cement concrete slab. It was evident that maintenance patching had been performed and more would soon be required. The distressed areas were being removed and replaced with asphalt concrete. Under the original contract in 1955, no provision had been made to correct even the worst failures in the rigid pavement before it was overlaid. The maintenance section of the airbase was patching this condition very closely and was repairing it as quickly as they could by digging out the loose chips and packing the void with bituminous concrete. This was being done to keep the jet motor damage to a minimum.

We picked up a few pieces of this spalled portland cement concrete which was lying loose in the joints. We have brought them along to show anyone who might be interested just what can happen to a rigid portland cement concrete slab after it has been in heavy use for a year or so by jet-type aircraft. You can easily imagine the damage one of these concrete chips would do to a jet engine if sucked up through the intake.

While we were on the field we observed the condition of the runways, taxiways, and aprons that had been built under previous contracts using all rigid portland cement concrete of 7-inch, 9-inch, and 19-inch depths. I would like to make the following comments:

1. All of the available parking area at Tinker Air Force Base was jammed with ariplanes. There was even parking on the alternate runways because of lack of space on the aprons.

2. I have never seen pavement either rigid or flexible that was as badly broken up and disintegrated as was this old rigid portland cement concrete pavement. There was harly a square yard that was not cracked, patched, or repaired in some way.

3. I would like to take this opportunity to commend the maintenance forces at Tinker Air Force Base. They have done remarkable work in keeping that

base in operation against the almost impossible working conditions of constant heavy use by all types of aircraft.

In closing let me state that in all fairness it would seem the Air Force owes an apology for the injustice done Imperial Paving Co. As a professional civil engineer, contractor, and taxpayer, the record of asphalt concrete pavement service at Tinker Air Force Base will prove that when all new construction is employed there is no differential, except cost, between the two types of pavement. The records on this project show that a square yard of rigid portland cement concrete pavement costs 175 percent more than flexible bituminous concrete pavement. If the cost experience at Tinker Air Force Base is typical, then building airfield pavements from other than flexible bituminous pavement in this Oklahoma portion of the country would be an extravagant waste of money.

STATEMENT OF AL KAVANAUGH, PRESIDENT, METROPOLITAN PAVING CO., INC., OKLAHOMA CITY, OKLA.

My name is Al Kavanaugh. I am president of the Metropolitan Paving Co. of Oklahom City, a businessman with approximately 20 successful years in the paving industry behind me, and by choice, a member of the National Bituminous Concrete Association, with whose views and statements, as they are presented to you here today, I associate myself in toto.

Indeed, it is through a recital of facts, based upon my own firsthand experience as a paving contractor to the Air Force, to the Navy, and to State and local governmental agencies, that I hope to give added force, clarity, and conviction to the association's presentation; in other words, to use myself and my firm as a classic example of what can befall, not only the average businessman, but a whole essential industry, where these are caught between arbitrary and inconsistent determinations on the one hand, and incomplete information which appears in the course of newspaper stories.

I am, however, frank to state to you, gentlemen, that my appearance here is not motivated solely by unselfishness. I have no wish to travel under false colors. I am, first and last, a typical American businessman, the head of a heretofore profitable and respected business venture whose greatest asset is the confidence and good will of the community it serves.

Today, Mr. Chairman and gentlemen, that confidence and good will has been grievously—and not, I fervently hope, irreparably—damaged as the result of a contract which my paving company entered into with the Air Force in good faith and carried out with integrity and professional know-how to the letter of the Air Force's specifications.

And that, gentlemen, is primarily why I am here—to seek at your hands—at this sole source of equity open to me—to rectify, first, a serious hurt to my business and, second, to an essential industry, that may well be doomed if certain harmful and unreasonable attitudes on the part of the Air Force in regard to pavement criteria are not checked now.

There is a third purpose to my being here, and that is to halt an inexcusable waste of the American taxpayers' money—as I shall demonstrate to your satisfaction a little later on—and I, too, am a taxpayer.

Here, then, are the facts:

In February 1954, my company completed a major asphalt concrete paving contract at Altus Air Force Base in Oklahoma.

The entire project included the paving of the present north-south runway, adjacent taxiways, and the apron, comprising a total area of 1,010,230 square yards of asphalt concrete pavement.

Our contract on this project called for the laying of 720,900 square yards. The contract to lay the remaining 289,300 square yards was awarded to the firm of Peter Kiewit Sons' Co.

Now, I do not think I have to describe to any of the members of this subcommittee the inspection procedures attendant upon the completion of any contract with any branch of the armed services.

To the highly commendable credit of our military such inspections are and have always been exacting so as to avoid any faults to a minute degree. So it was, upon the completion of Metropolitan's contract at Altus Airfield.

To the best of my knowledge, the work of my firm passed such an inspection without complaint upon the part of any officer, civilian official, or employee of

the Air Force or the Corps of Engineers charged with responsibility for passing upon our fulfillment of the terms and specifications of this contract.

To my full knowledge—and I give you this, Mr. Chairman, on my word as an honest businessman solicitous of the good name of his firm and the ethics of his industry—those terms and specifications were carried out to the letter of our contract with the Government. The best proof of this that I can offer you is that my firm was paid in full for its work.

Sir, we put down 720,900 square yards of asphalt concrete at Altus Airfield in accordance with the specifications. We assumed the pavement was designed to meet the intended load requirements.

Picture then, Mr. Chairman, my shocked consternation when—2 whole years later—on February 10, 1956, to be exact, I opened my daily newspaper to be greeted with headlines such as this—and with your permission, Mr. Chairman, I would like to read this one article to you so that it may become a permanent part of the record.

"ASPHALT CRACKS UP AT ALTUS AIRFIELD

"The Air Force has authorized replacement of more than 329,000 square yards of asphaltic pavement on the aircraft parking apron at Altus Air Force Base with portland-cement concrete, Col. Audrin R. Walker, commander of the 96th Bombardment Wing, said Thursday.

"Colonel Walker said it was decided, after extensive engineering analysis and surveys on the present apron parking, that it will not withstand present B–47 medium jet bomber traffic, and will not support B–52 heavy bombers due at Altus late in 1957.

"The present aircraft parking apron was designed when Altus was reactivated by the Air Force as a Tactical Air Command base using troop-carrier aircraft. Failure of the aprons under B–47 weights was announced several months ago."

Let me repeat this paragraph to you, gentlemen.

"The present aircraft parking apron was designed when Altus was reactivated by the Air Force as a Tactical Air Command base using troop-carrier aircraft. Failure of the aprons under B–47 weights was announced several months ago."

Here, gentlemen, is one of the high points of this matter. In plain, down-to-earth talk, somebody must have goofed in approving the apron design or failed to foresee the ultimate use to which it would be subjected.

According to the Air Force, as quoted in the above news story, the plans and specifications for the parking apron were designed to meet the requirements of the Tactical Air Command base using troop-carrier aircraft, and not the B–52's or the Strategic Air Command.

Consider now the very obvious difference in performance of the runway and the taxiways on the one hand (which are still in excellent working condition and serving heavy bombers), and the apron on the other.

It is pointed out that both were built by the same contractor, with the same equipment, with the same personnel, and with the same materials. By a process of elimination, therefore, a strong case can be made out for the probability that the apron design was inadequate. If we can accept the newspaper story as correct, then we must assume that the apron was designed to serve the purpose and the requirements of the Tactical Air Command only and not the heavy channelized traffic of the B–47's and B–52's. This apron did not fail under the traffic for which it was designed and constructed.

Since, with the chairman's permission, this entire news article will appear in the record, I will not take up your time with reading all of it here.

Recently, gentlemen, I had the opportunity to make a detailed inspection of the alleged damage reported in this news story. This was the first such inspection of the operational area at Altus which I was able to make since we finished our contract in 1954.

This inspection took place on May 14, 1957, in company with J. Rogers Martin, engineer for the Asphalt Concrete Association of Oklahoma. We were escorted over the field by Lt. Col. H. J. Cannon and Maj. G. M. Pexton, both of the Air Force.

We were totally surprised—and in view of all the adverse publicity which the so-called failure of asphalt concrete has received, both at Altus and other airfields—we were completely astounded by what we found.

We first made a detailed inspection of the runway and taxiways. As we rode slowly up and down the north-south runway, no evidence of any damage

was immediately apparent anywhere. Hence, we were dependent in assaying any failures upon the information furnished us by Colonel Cannon and Major Pexton.

Remember, the asphalt-concrete portion of this runway is now 10,000 feet long and 300 feet wide. Yet, the only damage Colonel Cannon and Major Pexton informed us of on this runway was to an area near the south end, approximately 100 feet in length and ranging from 3 to 6 feet in width. This area had undergone slight distress resulting in the development of a few cracks.

On the taxiways we observed 2 or 3 small areas which had failed, and had been replaced under a maintenance contract. We were also shown two distressed areas on opposite sides of one of the east-west taxiways where it intersected with the north-south taxiway. Each of these areas was about 6 feet square. The entire above-mentioned failed areas totaled approximately 1,200 square yards. Out of a total of 621,000 square yards of asphalt-concrete pavement, only 1,200 square yards, less than one-fifth of 1 percent, had shown distress when overloaded.

After our inspection of the taxiways and runways we proceeded to look over the apron. Unfortunately we were unable to see much of the reconstructed apron because it had been torn out to be replaced with portland-cement concrete.

We were shown a map upon which 12 purportedly failed areas were pointed out. These areas were practically all along a line a few feet wide, where B–47's had operated in a channelized pattern.

The total distress here comprised only 2,500 square yards or less. $50,000 would be a very liberal estimate for replacing all of these areas, which constituted three-quarters of 1 percent of the total area of the apron. (As a matter of fact, gentlemen, I would be happy to accept such a contract for the amount stated here and now. Incidentally, so would my competitors.)

This small distressed area could not have been the basis for replacing the entire parking area with portland-cement concrete at the tremendous sum of over $3 million. Whatever the true reason for the complete replacement was, the American taxpayer who paid for it and my firm who was blamed should have been advised. Instead, these small areas of failure, from overloading, were used as the basis for newspaper stories which were damaging to my firm.

The original parking apron was portland-cement concrete. Under my contract it was overlaid with a stone base, and an asphalt surface, and a new asphalt-concrete portion was added, all totaling 334,000 square yards, at a cost of $940,000.

A firm of consulting engineers, engaged to prepare plans and make recommendations, suggested a design which called for 11 inches of high-type asphaltic concrete directly above the old portland-cement concrete slab. This was rejected in favor of the less-expensive type of construction completed by me. Their recommendation, if followed, would have cost an estimated $1,428,000. Have you got these figures down, gentlemen?

The difference between the recommended expenditure of $1,428,000 and the actual $940,000 which my firm was paid amounts to an ostensible saving of $448,000. But was this money saved, Mr. Chairman? The result of this saving has now been an increased expenditure of $3 million for replacement, to which, unhappily, we must add the original $940,000 paid out for the lower-cost construction.

To sum up, the Air Force saved $448,000 of the taxpayers' money at a final increase in cost to the taxpayer of $2,512,000. This, gentlemen, is strange economy, indeed.

As a contractor and businessman, I am amazed at such a procedure. I am positive that proper maintenance practices could have kept the parking apron in good operating condition. As a taxpayer myself, it is difficult for me to understand why 99 percent of this apron, which was intact, was torn out and replaced with the most expensive pavement available. To me, this procedure is comparable to burning down a house and rebuilding it because some of the paint had scaled.

I sincerely thank the chairman and members of this subcommittee for the courtesy extended in granting me an opportunity to present my views.

[Story on front page of Daily Oklahoman, February 10, 1956]

(This story appeared in many newspapers in State.)

"ASPHALT CRACKS UP AT ALTUS AIRFIELD

"ALTUS, February 9 (Staff).—The Air Force has authorized replacement of more than 329,000 square yards of asphaltic pavement on the aircraft-parking apron at Altus Air Force Base with portland-cement concrete, Col. Audrin R. Walker, commander of the 96th Bombardment Wing, said Thursday.

"Colonel Walker said it was decided, after extensive engineering analysis and surveys on the present apron parking, that it will not withstand present B–47 medium jet bomber traffic, and will not support B–52 heavy bombers due at Altus late in 1957.

"The present aircraft parking apron was designed when Altus was reactivated by the Air Force as a Tactical Air Command base using troop-carrier aircraft. Failure of the aprons under B–47 weights was announced several months ago.

"Colonel Walker said it has been determined the base could continue operation of the 96th satisfactorily during the pavement replacement and still turn over approximately 94,000 square yards of apron area to the contractor for replacement at one time.

"The announcement was made by Colonel Walker after a conference of representatives of the Strategic Air Command, 15th Air Force, Air Force and Army engineering personnel from Texas, and interested 96th Wing officials.

"Maj. Gen. Lee Washbourne, Deputy Chief of Installations for Air Force, inspected the pavement areas and construction in progress on the base with Colonel Walker, and Col. R. B. Templeman, base commander.

"Design for the replacement will be made by Army engineers.

"Conference on preliminary drawings between the engineers and interested Air Force commands will be held April 10. Construction will be placed under contract prior to July 1."

STATEMENT OF H. S. KERR, VICE PRESIDENT, H. B. ZACHRY CO., SAN ANTONIO, TEX.

My name is Horace S. Kerr and I am vice president of the H. B. Zachry Co., of San Antonio, Tex. Our firm has built airfield pavements at Bergstrom, Kelly, and other Air Force bases. A recent inspection shows both of these bases to be serving military aircraft needs in full.

We have built asphalt concrete (flexible) pavements that are meeting the requirements of bombers, tankers, and fighter aircraft at these two bases. These pavements have been standing up under actual traffic and have done the job required of them.

Our recent inspection of the asphalt concrete pavement placed at Bergstrom Air Force Base, Tex., in 1952–53 reveals that the pavement is in perfect condition. The runways have given 4 years of service to practically all types of military aircraft, most frequently to the F–84F and F–84G jet planes. The tire pressure on the F–84F is 300 pounds per square inch and is as high a pressure as is used on the larger aircraft. The KB–29 tankers, the B–47, and B–36 aircraft have also used this field.

There is some evidence of fuel spillage on the asphalt concrete, but these areas show no sign of deterioration or distress from it.

There is no indication of any surface maintenance having been required during the 4 years Bergstrom Air Force Base has been in service.

Our firm built the test strip as well as the runway at Kelly Air Force Base.

It is my opinion that the severe accelerated concentrated loads applied to the best section do not represent the type of usage that will be applied to the runway pavement at any time during its years of service, and that the asphalt-concrete pavement as constructed on the Kelly Field runway will adequately serve any type of aircraft now in use. There is no doubt in my mind but that time will prove this to be true. In other words, I do not think that the test loads and the manner in which they were applied to the test section, represent in any degree the type of loads and methods of application of normal airplane traffic on the runway pavement. Also, these test loads were applied to a newly constructed pavement before it had seasoned.

After the test, when it had been decided to incorporate the test strip into the base's pavement facilities, we submitted an estimate for removing the top 5 inches of asphalt concrete. After observing initial results, the area engineer

elected to remove the top three-fourths inch only, which is about half of the wearing course. This material was soft. We used scarifier teeth on a maintainer as this was the easiest method of accomplishing our task. If the original specifications requiring the removal of 5 inches of asphalt concrete had been retained, a heavy plow would have been required as light equipment could not have achieved this.

The test strip was resurfaced with a mix as specified and used for the main runway. This was not used on the test strip which had a 5-percent asphalt mix. It is our conviction that the repaired section will stand up much better than the test section, although it was not placed with as much compaction.

Also, the actual aircraft traffic is intermittent in nature, permitting the pavement to recover from the applied loads. This was not the case in the test, as a kneading action from the continuous back-and-forth passage of the rollers was produced.

An inspection of the asphalt-concrete runway after 1 year's usage reveals that the pavement is in excellent condition.

STATEMENT OF SCHUYLER B. HUDSON

My name is Schuyler B. Hudson. I am a graduate civil engineer presently employed by the firm of Miller-Warden Associates. For the past 7 years I have been almost exclusively concerned with highway and airfield paving of both the asphalt (flexible) and portland cement concrete (rigid) types. During the period of 1950–53 I was responsible, as director of the paving inspection and testing division under the district public works officer, Sixth Naval District, for the construction and strengthening of a number of Navy jet fields such as MCAS Cherry Point, NAS Cecil Field, NAS Key West, NAS Pensacola, NAS Memphis and others. In 1955 I represented Miller-Warden Associates as consultant to the Corps of Engineers during construction and strengthening of the airfield pavements at Dover Air Force Base, Dover, Del. Most recently I have inspected the pavements at Dow Air Force Base, Bangor, Maine, Loring Air Force Base at Limestone, Maine, and the pavement at Dover.

On May 9, 1957 I visited Dow AFB at Bangor, Maine, and inspected the airfield pavements in the company of base commander, Col. Charles E. Lancaster, and A1O Maj. K. C. Baker. The existing asphalt runways of light duty design, built about 1941 are very rough and are showing signs of distress from the wheel loads of present-day plane traffic.

On the light duty parking apron which was paved and resurfaced with asphaltic concrete and tar-rubber in 1956, the construction joints between paving lanes have opened up and there is some random cracking. Joint and crack sealing is required. A short section of heavy duty asphalt taxiway constructed in 1956 was in perfect condition. The new portland cement concrete heavy duty taxiway-warmup apron and the small portion of one end of the runway so far constructed appeared to be in good condition. Minor shrinkage cracks were reported but were not seen on casual inspection. It was reported that no planes as yet had used any of the new Portland cement concrete pavement. The new heavy duty portland cement concrete heavy duty parking apron has 1 large crack extending through the center of about 6 to 8 paving panels and 1 smaller crack extending through about 5 slabs. These cracks were readily visible from the automobile in which I was riding, however, I did not have an opportunity to make a detailed inspection. In reply to a direct question the base commander stated that there were no other cracks of major significance.

So far as I have been able to determine the 15-inch thick concrete and the 40-inch selected gravel subbase were constructed in full accordance with the specifications and the concrete tested higher than the specified strength Apparently the cracks which I noted were serious enough to warrant a full investigation. I observed that a test pit had been dug near the largest crack and I would assume that the Corps of Engineers has made a complete investigation including a crack survey of the entire pavement. The portland cement concrete apron has not as yet been placed in service. At the time of my visit the placing of the concrete for the runway had not been resumed since the closing down of operations last fall and, according to the latest reports I have received, construction is still being held in abeyance.

On May 10, 1957, I visited Loring Air Force Base near Limestone, Maine, and talked with the base commander, Col. Gerard G. Wolke. The runway at this

base is of asphaltic concrete construction with portland cement concrete ends. The taxiway is also of asphaltic concrete as is a major portion of the parking apron area. The base is used primarily by B–52 planes.

Colonel Wolke stated that all pavement was performing satisfactorily with exception of a rough spot near one end of the asphalt runway, caused by a frost boil and a slippery condition on a portion of a taxiway which was caused by improper application of a jet seal.

I inspected the airfield pavement with the AIO, Maj. Frank D. Furlow. In general all pavement, both portland cement concrete and asphalt, was in good condition under the heavy B–52 traffic. I noted some random cracking of the asphalt pavement on the runway and taxiway and was told that these cracks were sealed as a routine maintenance operation in the spring but that they tended to close up in hot weather. There had been 2 minor repairs, each about 25 feet in diameter, in the asphalt pavement. Each was located near the end of the runway. I was told that one had been caused by a frost boil and that the other was defective pavement which had been replaced by the contractor at no cost to the Government.

The dimensions of the main taxiway A are such that the B–52 planes are confined to a very narrow path and the wheels pass repeatedly over almost the same spots. I inspected this taxiway very closely for signs of deformation but could find absolutely no indication of distress, rutting, or tire printing in either the taxiway or runway caused by channelized traffic. This also applies to the asphalt parking apron where B–52 and Kc–97 planes were parked with no indication of deformation or indentation.

I also talked with Mr. M. L. Jalber, roads and grounds supervisor, at Loring about pavement maintenance. He had no complaints about either type of pavement and found no difference between asphalt and portland cement concrete pavement as far as snow removal, debris sweeping, etc., were concerned. He said that maintenance of the pavement had been performed without serious interference with operations. The asphalt pavement had been constructed in 1950 and had been sealed as a routine maintenance operation 2 years ago. The concrete pavement had not been in long enough to require resealing of the joints. He stated that there were some cracks in the portland cement concrete pavement but that they were not large enough to require sealing with the exception of one crack extending through three panels of the portland cement concrete apron used as compass rose.

This crack at Loring is similar to those at Dow Air Force Base but probably has no structural significance as it is outside of loaded area of slab. Mr. Jalber said that there had been three cases of very minor damage to asphalt pavement caused by jet burns, but that these had been repaired by seal coating.

On May 16, 1957, I visited the MATS field at Dover Air Force Base, Dover, Del., and talked to Mr. Joseph Troller, area engineer, Corps of Engineers, and Mr. Gray, officer engineer. This field is used by C–124 and other heavy cargo planes carrying supplies to overseas bases.

In company with Mr. Gray I inspected portland cement and asphaltic concrete pavements which were constructed under my supervision in 1955. In general all pavement inspected was in good condition with the exception of the tar-rubber surface of the new parking apron which is developing some cracks at the construction joints and in the paving lanes. These cracks were not serious but could indicate progressive cracking. The portland cement concrete pavement was in good condition with the exception of unsatisfactory joint sealing and one small crack in the jet parking apron. The main taxiway of asphaltic concrete construction, was in perfect condition with no sign of distress or deformation from the heavy traffic of the C–124 planes and a large number of contract planes. The new runway of asphaltic concrete with concrete ends was not accessible due to the heavy traffic, but Mr. Gray stated there had been no complaints from operations. The old asphalt parking apron was in amazingly good condition.

With reference to the Navy jet fields with which I was concerned prior to 1953 I have had verbal reports that both the portland cement concrete and asphalt pavements have in all cases given satisfactory service and that no major items of maintenance, other than the deferred seal coating, have been required.

On April 22, 1957, I visited the Corps of Engineers Waterways Experiment Station at Vicksburg, Miss., and talked to Mr. W. J. Turnbull and Mr. C. R. Foster about the tests of portland cement concrete and asphaltic concrete pavement at Kelly AFB. In general Mr. Turnbull and Mr. Foster stated that, in their opinion, the failure of the asphaltic concrete surfacing in the above test was due

entirely to an excess of asphalt in the mix for the test conditions. The use of the specified amount of asphalt was due to failure to accurately extrapolate the effect of 30,000 coverages, applied at the rate of 500 coverages per day at high pavement temperatures, from the 1,500 coverages normally used for pavement design. Furthermore, that the pavement design used at Kelly Field would, in their opinion, be suitable for actual use under prototype traffic, with the possible exception of a slight reduction of asphalt content (about one-half percent).

Following the Kelly test several pavement sections had been constructed and tested at waterways experimental station in June–August 1956. The test conditions were as nearly as possible the same as at Kelly with channelized traffic, 100,000-pound wheel load and 200 pounds per square inch tire pressure. Several variables were included in the test items of asphalt pavement surfacing and most of the items passed the 30,000 coverages successfully. In view of the good performance of the taxiways—at Dow and Dover—I am of the opinion that the Kelly test was too severe for correlation with actual service requirements, but that asphalt pavement can be designed to meet the conditions of the Kelly test, if necessary.

In connection with my inspections of airfield pavements I have observed that there is no type of construction which is entirely free of construction or maintenance difficulties. In cold climates extensive cracking of high-quality portland cement concrete on a carefully prepared subbase may occur as in the case of the newly constructed heavy-duty parking apron at Dow Air Force Base, Bangor, Maine. If improperly constructed, portland cement concrete is subject to cracking and settlement from lack of subgrade support, spalling the joints, and even disintegration of localized areas. In many areas periodic resealing of joints is required. Tar-rubber concrete tends to shrink and crack along construction joints requiring resealing. Asphaltic concrete, of airfield quality, is subject to shrinkage cracks which require seal coating with the proper materials.

As a result of my close contacts with the problems involved in constructing, repairing, and maintaining airfield pavements I am of the opinion that the most favorable economic balance is obtained, under present conditions, by maintaining the policies established by the 1954 hearings.

There appears to be a definite economic advantage in using asphalt (flexible) pavements for the portion of the runway of jet fields between the concrete ends and for the tangents of taxiways. Asphaltic pavement is also giving good service on parking aprons for conventional aircraft as on the large parking apron at Dover Air Force Base used for C–124 planes and the asphalt apron at Loring. Although I am of the opinion that the damage done by jet-fuel spillage and jet blast has in some cases been exaggerated, the fact that it has occurred appears to justify the use of the more expensive portland cement concrete pavement for runway ends, and for warmup aprons, parking, and service aprons; and refueling areas for military jet aircraft.

In summary, my experience and observations are that asphalt pavement can be constructed to give satisfactory service in noncritical areas with prototype aircraft. There is a definite economic advantage in such construction, particularly in areas where the native soil is granular or where frost conditions are severe.

Statement of Warren B. Warden

I am Warren B. Warden, owner and manager of Miller-Warden Associates, a firm of consulting engineers, with principal offices in Swarthmore, Pa., and branch offices in Raymondville, Mo., and Chicago, Ill. I am a graduate, registered professional engineer.

With me is our technical director and manager of our civil engineering department, Mr. Schuyler B. Hudson, a graduate civil engineer, experienced in both asphaltic concrete and portland cement concrete pavement construction. Mr. Hudson was formerly director of the Washington Testing Laboratory. In response to a request from the Navy during the war for concrete specialists he volunteered and served on active duty as lieutenant commander. Immediately before joining Miller-Warden Associates in 1953, he was director of the Paving and Testing Division of the Sixth Naval District (covering the seven Southeastern States). Various other members of our staff, including two recent employees of the Portland Cement Association, have collaborated in the preparation of this statement.

We have been retained by the National Bituminous Concrete Association to study the issues involved in this hearing and to render an objective report as

to our findings. We have been told that one of the reasons for the selection of our company was because we have had experience in both asphaltic concrete and portland cement concrete highway and airfield construction.

We were, for instance, quality control and bituminous consultants on the Garden State Parkway in New Jersey, a major toll road largely of asphaltic construction. We are currently quality control consulting engineers on the Illinois toll road which is largely of portland cement concrete construction. In 1955 we were retained by the Philadelphia district of the Corps of Engineers as consultants on the construction and strengthening of the airfield pavements at Dover Air Force Base, Dover, Del.

In addition we have worked for various contractors, agencies, and owners on miscellaneous projects involving both asphaltic and portland cement concrete pavements. Thus we are experienced in both types of construction and we have no proprietary interest in either of the two major products involved.

We have carefully and thoroughly reviewed all pertinent data available to us. These included the minutes of the 1954 hearings of this subcommittee, as well as various other reports and conference minutes.

Incidentally, Mr. Hudson attended the Hueneme conference. He has recently visited Vicksburg and discussed the Kelly test and other work underway at the waterways experiment station. He has inspected pavements at Dow Air Force Base in Bangor, Maine (May 9, 1957), and Loring Air Force Base near Limestone, Maine (May 10, 1957). On May 16, 1957, he visited Dover Airbase and inspected the pavements constructed under his supervision in 1955.

We have reviewed our files on previous inspections made by one of our former affiliates on a relatively large number of bases in 1952. The situation at Lincoln Air Force Base has been discussed with another of our affiliates, Mr. Paul Sonderegger, president of Western Laboratories, Inc., of Lincoln, Nebr. (the principal title II consultants in charge of supervision of construction). Mr. Sonderegger has recently returned from Thule and gave us a firsthand report on the condition of the pavements on this important base. Finally, Mr. Hudson has had a verbal report of pavement conditions following a recent inspection of the Navy airbase in the 6th Naval District; much of the pavement at these bases was placed under his supervision.

Our findings from the above studies and inspections are summarized herein. In preparing this summary we have objectively separated fact from opinion. We also realize that there have been and from time to time probably will be occasions wherein an exception might be cited. By and large, however, we feel the following points are an objective engineering appraisal of the issue and all are subject to verification. The pertinent facts are:

(1) Asphaltic concrete and portland cement concrete pavement are historically alternate competitive types of construction. Both types are satisfactorily serving B–47, B–52, and our heaviest cargo transport planes.

(2) From actual bid prices on airfield paving it has been established that asphaltic concrete pavement is lower in cost than portland cement concrete pavement. While this cost difference will vary widely depending on local conditions, in many cases from 1½ to 2 times as much pavement of comparable design can be constructed of asphaltic concrete as can be constructed for the same number of dollars using portland cement concrete.

(3) Reliable comparable maintenance costs are not available for military airfields due to the method of bookkeeping. A very large part of the routine maintenance is sweeping for all military fields and snow removal where necessary. We find that the reported costs for these major items are the same for both portland cement and asphaltic concrete pavement under comparable service conditions. Highway maintenance cost comparisons are not applicable. By and large, overall pavement maintenance costs are probably about equal for the two types of construction.

(4) Both types are subject to damage and to repair costs if improperly constructed. If the subgrade support is inadequate, portland cement concrete pavement cracks and must eventually be overlaid with asphaltic concrete or torn out and replaced. If the subgrade support is inadequate, the asphaltic concrete will settle unevenly and must be patched or overlaid to restore it to grade. When these conditions exist the cost of repair to restore grade and place the pavement in usable condition will normally be greater for the portland cement type.

If the subbase is not properly constructed with suitable materials, under severe frost conditions portland cement cracks and asphaltic concrete develops

frost boils. Again the cost of repair will normally be less with the asphaltic construction.

(5) Improper operation of jetplanes and/or improper housekeeping resulting in excessive fuel spillage causes small localized damage to asphaltic concrete pavement and damage or localized removal of the joint sealer on portland cement concrete. It is our finding that damage due to jet blast and/or fuel spillage in noncritical areas as defined in the 1954 hearings is usually not serious from an operational viewpoint and the repair cost is relatively inconsequential. Because this type of defect is so readily noted on casual inspection, the effects of jet blast and fuel spillage have, in some cases, been overemphasized without factual basis for judgment as to its actual seriousness either from an operational standpoint or with respect to repair costs.

(6) There is no question that both types of pavement can be designed and constructed to give satisfactory service with present aircraft. This has been amply demonstrated by actual operation and numerous examples have been cited. Mr. Hudson will report further on both Loring and Dover Air Force Bases in this regard.

At Loring, for instance, I have a report which states:

"Absolutely no rutting or tire printing on the asphaltic concrete runway or on the asphaltic concrete taxiway under channelized B–52 traffic. B–52 and KC–97 planes parked on an asphaltic concrete apron with no deformation or indentation."

(7) Both types of pavement are subject to failure, if subjected to overload. Both types, however, may be strengthened within limits and the usual method consists of adding an overlay. Either asphaltic concrete or portland cement concrete overlays may be used, and each may be used over either type of existing pavement.

Significantly, the amount or thickness of a portland cement concrete overlay required for a given degree of strengthening over an existing asphaltic pavement is not much thicker than that required over a portland cement pavement. In general, the required asphaltic concrete overlay on an existing asphaltic pavement is a more simple and more economical operation than placing a portland cement concrete overlay over either asphaltic or portland cement pavement.

(8) The much discussed Kelly test was clearly an example of test conditions being too severe for correlation with actual service performance. However, asphaltic concrete pavements can be and subsequently have been designed and constructed which met the conditions of the Kelly test.

It is our opinion that completed work at Vicksburg, as well as our own experience in mix design and field observations, substantiate the conclusion that satisfactory asphaltic concrete pavement which will withstand any realistic loading and channelized repetitions for prototype traffic has been and can continue to be constructed under practical working conditions in the field.

These, then, are the pertinent facts as we see them.

Now, just what do these findings mean relative to the problem at hand. First, what is the problem? What is the real meat of what we are all trying to accomplish? The problem, as we see it, is to define means, under the American free-enterprise system, of providing adequate and suitable airfields for our military planes at any time in any location at the least overall cost to the taxpayers. Let's briefly take this definition apart a step at a time in light of our findings.

"Under the American free-enterprise system" means under a competitive system. The Portland Cement Association has done and is doing an admirable job of promoting their technology and with the Rigid Pavement Section of the Corps of Engineers and others have greatly advanced our knowledge and ability to build better airfield pavements.

By the same token, the Asphalt Institute, the National Bituminous Concrete Association, and others such as the Flexible Paving Branch of the Corps of Engineers play their important parts in contributing to our technology, know-how and abilities to also build better airfield pavements. Free competition among our equipment manufacturers is giving us new and better machinery for both types of construction. The chemical manufacturers are making remarkable strides in giving us asphalt additives of various types and new and better air-entraining agents and admixtures for portland cement.

This competition is the very heart of our technological advancement and any arbitrary rulings, policies, or directives which inhibit free competition endangers our overall future ability to compete with a common potential enemy to this well-proven American system.

"At any time" means peacetime, wartime, and future time. During peacetime we can take the time to import suitable aggregate and concrete sand; we can transport portland cement and wait for it to harden; we can obtain reinforcing steel, etc. In peacetime the main consideration should be cost.

In wartime, the military may be able to obtain top priorities but this normally means someone or something down the line suffers. Let's be realistic, in wartime we will still build our airfields, including the so-called critical areas, all over the world from local materials with the most rapidly available binder, which usually means asphalt. Transportation considerations alone make this reasonable since it takes about 400 pounds of portland cement but only about 25 pounds of asphalt to build one square yard of pavement.

Therefore, we cannot afford to neglect asphalt technology in peacetime. We must have the trained technicians, the qualified engineers and the experienced contractors ready and able to do the job with both types of material.

Now let's briefly consider future time. No one knows what kind of wheel loads our pavements must support in the future. The atom powered plane may necessitate scrapping both the traditional types of pavement as we know them today. Realistically planning for the foreseeable future is good engineering but building "pie in the sky" for something we don't know about in an era of unprecedented scientific advancement is neither good engineering or economy. As stated, both types of construction will fail if overloaded and we just don't know what the design criteria of the future should be.

We do know that both types can be strengthened and that flexible base construction is suitable for both portland cement and asphaltic concrete overlays. Even the exaggerated Kelly test (by today's standards) failed to damage the flexible base construction used.

We are paying for today's airfields with today's tax dollars and both types of construction provide adequate and suitable pavements for today's military planes. Let scientific advancement in all phases of our free-enterprise system work unhampered to provide the answers to future problems for future planes.

At any location means both north and south. In hot climates the design of asphaltic concrete mixes tends to be more critical because of the thermoplastic nature of the binder. In cold climates the design of portland cement concrete tends to be more critical because of the effects of frost action on the rigid slabs. Thus each type has its minor problems relative to service climate.

At any location means in areas having a short construction season and here asphalt has the advantage because of the faster rate of construction.

At any location also means areas close to a good source of suitable concrete aggregate as well as areas wherein long and expensive hauls are necessary. Unfortunately in many areas of the country the supply of prime aggregates for both types of pavement is nonexistent or is rapidly becoming depleted. This is of importance for the expedited highway construction program as well as for airfields. Much good work is being done on the better utilization of local materials. Here again asphalt has the advantage since a much wider variety of aggregates and sands are suitable for asphaltic construction.

Thus there are some factors relative to "location" considerations in this problem. It does not appear logical to us that any arbitrary rulings can hope to provide the best answer for all locations. Conversely it is logical that competitive incentives and competitive bidding will lead to the better utilization of local materials and to the better utilization of the experience of local contractors, local suppliers and local engineers in handling the special problems associated with that particular climate, areas, and environs.

Before leaving location considerations, I would like to digress for just a moment to make a point that we feel is important to the overall economy of the country with relation to paving in general. The findings of these hearings and the statements made relative to the issues involved in the construction of military airfields may influence those concerned with deciding the type of pavement to be used on civil airports, etc., and particularly on the vast highway improvement program now underway—one part of which involves some 40,000 miles of the Interstate System to be paid for 90 percent from Federal funds.

It should be made perfectly clear to all that inferences from these discussions and the opinions expressed in these sessions apply only to extremely high wheel loadings, channelized repetitions, etc., for military jet planes and have no bearing whatsoever on the design criteria or anticipated service for vehicular traffic or for lighter planes. The temptation for salesmen to improperly use generalized statements for promotional purposes is ever present.

We feel that everyone concerned should fully qualify their statements and opinions as applying to military airfields only, so that improper inferences cannot be drawn which may unduly and very erroneously influence the choice of pavement for other totally unrelated services. There is just no comparison between the heaviest loaded truck and the jet plane gear loadings under consideration herein.

Least overall cost may be broken down into four items for purposes of analysis: (*a*) Construction, (*b*) maintenance, (*c*) damage repair, (*d*) strengthening.

(*a*) Construction costs are normally lower for asphaltic concrete. To remove asphaltic concrete pavement construction from its favorable competitive position will undoubtedly result in an increase in the bid price of portland cement concrete.

The use of percentage figures should be discouraged for the sake of clarity and uniform understanding of these important cost considerations. We feel that expressing the savings or cost difference in percentage figures as has been attempted in various reports and as used in the 1954 hearings leads to confusion, is subject to misinterpretation and may be downright misleading.

The straightforward way of expressing this cost difference is to simply state that for a given field the savings is so many dollars per square yard of pavement; or, if one must generalize, then to state, as we have done, that currently in many cases 1½ times to twice as much pavement can be constructed for the same number of dollars.

(*b*) Maintenance costs, as stated previously, are probably a standoff for the two types of pavement.

(*c*) By damage repair costs we mean the cost of reactivating an airfield that has been damaged by enemy action. In general we feel that the cost of repairing damaged asphaltic pavement is less, although this will admittedly depend on the type and extent of damage. Cracked or dislodged slabs, however, are traditionally expensive to break out and replace. In wartime the timing factor overshadows cost considerations and here asphalt has a definite and obvious advantage.

(*d*) Strengthening costs can be an important consideration. Whereas we do not know what loads the future planes will impose on our pavements, we can do some worthwhile engineering planning to minimize the cost of strengthening pavements to handle reasonably higher loads. As stated previously either portland cement or asphaltic concrete overlays can be used over either type of existing pavement.

In general, due to the design and construction methods used, asphaltic pavement bases are more adaptable to strengthening than are the relatively thin subbases normally specified under portland cement concrete pavement. In fact, over a soft clay type elastic subgrade it may be necessary to break out the existing portland cement concrete pavement and rebuild the base before adequate strengthening can be obtained. This is admittedly more important over certain types of elastic soil subgrades than it is over granular basement materials.

Since asphaltic concrete overlays are usually lower cost and, in any case, the thickness of portland cement concrete overlay required over existing asphaltic pavement is not much thicker than that required over cement concrete, the overall cost, if strengthening ever becomes necessary, may be substantially less with an original asphaltic base construction.

Based on the pertinent facts listed and on the analysis presented as to their significance relative to the problem at hand it is our conclusion that asphaltic concrete and portland cement concrete pavements are competitive from both a service and maintenance standpoint, and that there is a definite economic disadvantage in excluding asphalt from military airfield construction. Further, that the removal of competitive incentives (1) would seriously jeopardize the continued development of improved techniques, equipment, materials, and know-how for airfield construction; (2) would jeopardize the flexibility with which military airfields could be rapidly constructed, repaired and/or strengthened in time of emergency; and (3) would inhibit our ability to utilize local materials, equipment and manpower to best advantage for the benefit of the military and our country as a whole.

We recommend, therefore, that the military specify to the overall paving industry realistic service requirements for airfield paving and give our Ameri-

can free enterprise system full and uninhibited rein to meet these requirements both now and in the future.

MILLER-WARDEN ASSOCIATES,
By W. B. WARDEN.

Mr. HÉBERT. Mr. Griffith, you will supply this committee with the letter from Mr. Zachry?

Mr. GRIFFITH. Yes, sir.

Mr. COURTNEY. The letter from Mr. Zachry. That may be made a part of today's record, Mr. Chairman.

Mr. HÉBERT. Thank you very much, Mr. Griffith, for your attendance and testimony.

Mr. GRIFFITH. Mr. Hébert.

Mr. HÉBERT. Yes.

Mr. GRIFFITH. May I make one correction?

Mr. HÉBERT. Yes.

Mr. GRIFFITH. In my testimony.

Mr. HÉBERT. Yes.

Mr. GRIFFITH. As to the source of the concrete particles, that Mr. Bates raised. I said the grade control conference. It was the conference on pavement maintenance.

Mr. HÉBERT. All right.

Thank you, gentlemen, very much. The committee will stand in recess until 10 o'clock, Wednesday morning, at which time, Mr. Courtney, I would like for you to ask the engineers——

Mr. HESS. The Air Force too.

Mr. HÉBERT. The Air Force.

Mr. COURTNEY. The engineers and the Air Force, those officers who were previously requested, and the Department of the Navy is represented, I believe.

Mr. HÉBERT. We will hear them on Wednesday at 10 o'clock.

Mr. COURTNEY. On Wednesday of this week.

Mr. HÉBERT. At 10 o'clock.

Mr. COURTNEY. Which is the 3d of July.

Mr. HÉBERT. The committee will stand in recess.

(Whereupon, at 12:08 p. m., the subcommittee was adjourned, to reconvene at 10 a. m., Wednesday, July 3, 1957.)

AIRSTRIP PAVING MATERIALS

WEDNESDAY, JULY 3, 1957

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE FOR SPECIAL INVESTIGATIONS,
Washington, D. C.

The subcommittee met at 10 a. m., the Honorable F. Edward Hébert, chairman of the subcommittee, presiding with the following members present: Mr. Cunningham, Mr. Bates, Mr. Osmers, and Mr. Miller.

Mr. COURTNEY. Mr. Griffith, I think you have some additional data for the record which was referred to in your testimony, and also in your prepared statement.

Mr. GRIFFITH. Yes, sir; Mr. Chairman, in response to your request I have here the letter from the H. B. Zachry Co. that you requested the day before yesterday. I ask that be included in the record.

Mr. HÉBERT. Without objection, it will be put in the record at the point we were discussing yesterday.

Mr. COURTNEY. That is right.

H. B. ZACHRY CO.,
San Antonio, Tex., March 5, 1957.

Mr. SHELDON HAYES,
S. G. Hayes & Co.,
Harvey, Ill.

DEAR SHELDON: Re the questions that you have raised regarding the Kelly job: We submitted an estimate on removing the whole 5 inches. The estimate was rather high as we anticipated difficulty in scarifying. The area engineer, after observing initial results, elected to remove only part of the wearing course.

We used scarifier teeth on a maintainer. The upper surface was soft and easy to scarify. We bladed off the loosened material with a maintainer and actually only removed about ¾ inch or approximately half of the wearing course. Had the full 5 inches of hot mix been removed, we believe the scarifier might have been insufficient and some type of heavy plow would have been necessary.

The repaired surface consisted of surface course six as specified for the main runway (not what was originally in the test section which contained 5 percent asphalt). We believe the repaired test section will stand up much better than the original test section, even through the repaired layer was not placed with nearly as much compaction effort as the original test. For one thing, the pavement will have had the better part of a year of curing. For another, actual plane traffic will be normally intermittent and not a kneading action such as we gave it in the test by repeatedly passing a roller back and forth without there being sufficient time for recovery.

I enjoyed meeting with you again in Dallas and hope that this information is what you desired.

Yours very truly,

J. D. LANG.

Mr. GRIFFITH. Also, I have here with me some additional information that has been prepared and I respectfully ask permission to include it in the record. I think the committee in considering it will find it of importance to them.

Mr. COURTNEY. What does it relate to in general, Mr. Griffith?

Mr. GRIFFITH. First, I have a list here of various airfield construction bids that were requested since January 1. There are some 31, amounting to a total of approximately $108 million.

This proposed construction includes paving. To our knowledge, none of this provides for alternate bidding for asphaltic concrete in those areas not considered critical by the 1954 hearings.

Mr. COURTNEY. That will be made a part of his statement——

Mr. HÉBERT. Let me ask a question there. Did I understand what you said was that paving was asked in noncritical areas?

Mr. GRIFFITH. These requests for bids——

Mr. HÉBERT. Yes.

Mr. GRIFFITH. Cover all types of work, at various airfields. Included in that work is items for paving. To the best of our knowledge, alternate bids was not asked for paving in those areas considered noncritical by the 1954 hearings.

Mr. HÉBERT. Now, were bids asked prior to the directive of the Department, or after the directive in 1956?

Mr. GRIFFITH. All of this, sir, a period of January 1, 1957.

Mr. HÉBERT. After the Department had issued its arbitrary directive?

Mr. GRIFFITH. Yes, sir.

Mr. HÉBERT. All right.

(The construction bids are as follows:)

Bids asked since Jan. 1, 1957, military airfield construction—asphalt concrete alternate not included

Name	Location	Bid No.	Amount	Mission	Description
Rosecrans Field	St. Joseph, Mo	57-30	$747,865	ANG	Runway and taxiway extension; 30,000 square yards of 7-inch concrete pavement removal; 35,000 square yards of 8-inch concrete pavement, 38,000 square yards of 9-inch concrete pavement, 20,000 square yards of 8-inch concrete pavement patching; 190,000 lineal feet of joint-routing, resealing, and repair.
Niagara Falls AFB	Niagara Falls, N. Y	57-36	1,722,453		Runway extension, including concrete pavement for runway extension, concrete pavement for taxiway extension and warmup holding apron; concrete pavement for taxiway widening.
Natrona County Airport	Casper, Wyo	57-41	243,423		Extension runway.
Gore Field	Cascade County, Mont	57-31	1,255,840		Paving runway and apron.
Fort Smith Municipal Airport	Fort Smith, Ark	57-50			Extension 275 x 422 feet to existing aircraft parking apron. Pavement to be portland cement concrete 9 inches thick placed on 6-inch previous layer.
Byrd Field	Richmond, Va	57-30	987,280		Runway extension and reinforcement, runway 15-33.
Vance AFB	Tulsa, Okla	57-12	674,890	ATC	Runway extension.
Mather AFB	California	57-40	7,821,923	ATC	Extension taxiway and runway widening concrete for landing jet bombers, operational apron and facilities.
Amarillo AFB	Texas	57-53	12,307,715	ATC	Runway approximately 950,000 square yards portland cement concrete 7 taxiway and aprons.
McConnell AFB	Kansas	57-46	403,760	ATC CACR	Apron parking, additions. Parking apron, removal and relocation of existing facility.
Donaldson AFB	South Carolina	57-26	949,939	CACR TAC	Paving operational airfield apron.
Davis Airfield	Muskogee, Okla	57-43	1,308,355	CACR	Runway new NW-SE and taxiway.
Bradley Field Air Force Reserve Flying Center.	Windsor Locks, Conn	54	933,672	CACR	Utilities pavements.
Beale AFB	California	57-43	10,261,686	CAC	Runways, taxiways, apron, and facility.
Suffolk County AFB	New York	340	1,939,202	ADC	Runway extension FX-1957 program.
Sioux City AFB	Sioux City, Iowa	57-76	834,444	ADC	Paving airfield and hydrant fueling, including widening and extending existing runway, approximately 9,000 feet transfer line, et cetera.
Grandview AFB	Missouri	43	744,869	ADC	Runway extension north-south.
Grand Forks AFB	North Dakota	57-49	11,697,161	ADC	Airfield pavement, with concrete pavement ranging 16 to 24 inches thick. Runway will be the second of such length extending to 12,350 feet, authorized by the Air Force to be built of portland cement concrete, to exacting specifications.
McClellan AFB	California	57-41	1,984,444	AMC	Runway primary extension and facility.
Griffith AFB	Rome, N. Y	57-67	16,742,731	AMC	Runway and taxiway support facilities.
Brookley AFB	Mobile, Ala	57-41	1,269,947	AMC	Widening and strengthening runways, taxiways and warmup pad.
Holloman AFB	New Mexico	57-51	1,718,124	ARDC	Taxiway and aprons, approximately 106,000 square yards of concrete paving for aircraft.
Edwards AFB	California	73	342,148	ARDC	Access apron, base maintenance hangar No. 2.
Travis AFB	do	57-30B	179,300	SAC	Operational apron shoulder.
Do	do	57-49	3,437,283	SAC	Runway parallel and facilities.
Columbus AFB	Columbus, Miss	57-70	6,391,717	SAC	Primary runway ends, taxiway and aprons, lengthen 2,000 feet and sub. work.

Bids asked since Jan. 1, 1957, military airfield construction—asphalt concrete alternate not included—Continued

Name	Location	Bid No.	Amount	Mission	Description
Bergstrom AFB	Austin, Tex	57-25	9,105,943	SAC	Paving airfield, runway, taxiway, apron, hydrant fueling, flexible pavement, et cetera.
Castle AFB	California	57-120	146,853	SAC	Taxiway, runway, access roads, concrete, approximately 600 feet by 75 feet, with 50 feet bituminous shoulders over a stabilized aggregate base.
Naval auxiliary land field	Alice-Orange Grove, Tex	NPy-1168 B	1,787,600		Complete duty runway, 8,000 by 200 feet, taxiways.
Naval air station	Olathe, Kans	5609	250,750		Construction of runway, taxiway, apron repairs.

Mr. GRIFFITH. Now, the committee will recall that in Mr. Kennedy's presentation for the Portland Cement Concrete Association it made quite a point of the ability of portland cement concrete to meet the smoothness tolerances required by the Air Force in its effort to prevent porpoising or bouncing. The implication, at least, that I drew from the testimony was that only portland cement concrete could meet these very severe tolerances. I have here a letter from one of our members, Mr. Henry H. Claussen, in which he points up—he was the subcontractor on a job at Robins Air Force Base. It was completed in 1956.

Mr. COURTNEY. That is at Macon, in the State of Georgia, Mr. Chairman.

Mr. GRIFFITH. He laid 140,000 tons of asphaltic concrete on the interior of a runway, which was 10,400 feet long and 300 feet wide. He also laid this material as an overlay on other pavement areas which were portland cement concrete and had disintegrated. I would like to read from his letter:

The Air Force informed the Corps of Engineers that the tolerance of one-eight inch in 15 feet on the surface would be strictly adhered to.

That should be 16 feet.

I continue the quote:

Needless to say, this was quite a task, but it was done, and the job completed with density, stability, and tolerance all within the specifications. The asphalt on this job actually checks to tolerances closer to the portland cement concrete ends. The runway has been in use only 4 months, but so far there has been no failure.

(The letter is as follows:)

CLAUSSEN-LAWRENCE CONSTRUCTION CO.,
Augusta, Ga., August 14, 1956.

Mr. H. K. GRIFFITH,
Executive Director, National Bituminous Concrete Association,
Washington, D. C.

DEAR MR. GRIFFITH: We have your letter of August 7 requesting any information we might have on flexible pavement in airfield construction.

Relative to paragraph 6 of your letter, we understand the Corps of Engineers will let a job on the Charleston (S. C.) Air Force Base in the near future which was to have been asphalt but has been changed to portland cement concrete overlay and extension.

This firm recently completed a subcontract on the asphaltic concrete work for MacDougald Construction Co., of Atlanta, Ga., at the Robins Air Force Base at Macon, Ga. The project consisted of 1 new runway 10,400 feet long and 300 feet wide with 7-inch waterbound macadam base and 2½-inch binder with 1½-inch surface. The runway ends for 1,000 feet were of 15-inch portland cement concrete. The job also included overlay of existing portland cement concrete runways with 6 to 8 inches of asphaltic concrete. Total tonnage involved was aproximately 140,000. The project was under the supervision of the Corps of Engineers, Savannah district.

The Air Force informed the Corps of Engineers that the tolerance of one-eighth inch in 16 feet on the surface would be strictly adhered to. Needless to say, this was quite a task, but it was done, and the job completed with density, stability, and tolerance all within specifications.

The asphalt on this job actually checks to tolerance closer than the portland cement concrete ends. The runway has been in use only 4 months, but so far there has been no failure.

We might add that the old portland cement concrete runways that were overlaid with asphalt, and were built originally around 1942, had cracked very badly in the touchdown area under the extremely heavy traffic of all types of planes at

the base. If you are in the vicinity of Macon, it might be well worth the time to try to get in to inspect this project.

Yours very truly,

CLAUSSEN-LAWRENCE CONSTRUCTION CO.
HENRY H. CLAUSSEN, *President.*

P. S.—We received a telegram today postponing the Columbus Air Force Base asphalt paving job indefinitely. It may be that this job, too, is being changed to concrete.

Mr. GRIFFITH. I might add that since the imposition of those very rigid tolerances there has been a relaxation, of recent date. Our contractors knew of the impending relaxation and considered it seriously.

Mr. COURTNEY. You mean the relaxation in criteria by the Air Force?

Mr. GRIFFITH. Of tolerances.

Mr. COURTNEY. Of tolerances.

Mr. GRIFFITH. Smoothness tolerances. They took the position that, if that was what was required, they would make no objections, although it was difficult to lay. Now, the next two items are copies of letters from members of the Corps of Engineers to one of our contractors.

The first letter deals with the period of 1943. This was on Morrison Field, an Air Force base in Florida. It involved $925,000 for the reinforcing and extending of runways at Morrison Field. I shall quote here:

This office was especially pleased with the manner in which you were able to complete badly needed portions of the work when required by the Air Force. The cooperative spirit of your organization in handling this work permitted this field, one of the most important in the United States, to remain in almost constant operation while all runways were completely resurfaced. A record was established in the district, if not for the country as a whole, when, in 7 days, during the period June 4 through June 20, 1943, a total of 13,265 gross tons of hot plant-mix asphalt was placed. The completion of this portion of the work as scheduled, which involved the resurfacing of the runway intersections, permitted the field to operate—

and I emphasize "permitted the field to operate"—

at a time when it was most vitally needed.

I need not point out to you the seriousness of our situation in 1943 along the east coast.

The second letter is some 11 years later. It deals with the same sort of a problem, and it compliments the contractor on his ability to work 24 hours a day around the clock, between the period of December 21 to 31, 1953, which was brought about by the requirements of the Air Force, the operational requirements of the Air Force.

(The letters are as follows:)

WAR DEPARTMENT,
UNITED STATES ENGINEER AREA OFFICE,
JACKSONVILLE, FLA., DISTRICT,
Miami Beach, Fla., December 21, 1943.

Mr. J. M. RUBIN,
Wesco Construction Co.,
West Palm Beach, Fla.

DEAR MR. RUBIN: It is desired at this time to express to you and to your personnel the sincere appreciation of this office for the splendid manner in which you conducted construction operations under your contract No. W–436–eng–9910 for reinforcing and extending runways at Morrison Field, $925,254.75, was at all times well ahead of schedule.

This office was especially pleased with the manner in which you were able to complete vitally needed portions of the work when required by the Air Forces. The cooperative spirit of your organization in handling this work permitted this field, one of the most important in the United States, to remain in almost constant operation while all runways were completely resurfaced. A record was established in this district, if not for the country as a whole, when in 7 days, during the period June 14 through June 20, 1943, a total of 13,265 gross tons of hot plant mix asphalt was placed. The completion of this portion of the work as scheduled, which involved resurfacing of the runway intersection, permitted the field to operate at a time when it was most vitally needed.

It is definitely considered by all concerned that the coming of your company into this area has brought a "new day" in asphalt paving to this State. Please accept our sincere thanks for the very substantial part your work has played in gaining for the West Palm Beach area engineer office a very high standing in the Jacksonville engineer district.

Yours very truly,

D. E. EPPERT,
Captain, Corps of Engineers, Area Engineer.

CORPS OF ENGINEERS, UNITED STATES ARMY,
OFFICE OF THE DISTRICT ENGINEER,
JACKSONVILLE DISTRICT,
Jacksonville 4, Fla.

RUBIN CONSTRUCTION CO.,
West Palm Beach, Fla.

GENTLEMEN: Reference is made to your contract No. DA-08-123-ENG-1440 for rehabilitation of airfield pavement, Palm Beach Air Force Base, West Palm Beach, Fla.

All work under the referenced contract was completed in accordance with the terms thereof and to the satisfaction of the undersigned on March 4, 1954. All work is accordingly accepted as of that date.

The contract provided that the pavement overlay on existing runways, phases 1, 2, 3, and 4 be accomplished during the period December 21-31, 1953, which required operations on a 24-hour-day basis. It also provided that the work be accomplished in such manner as to cause a minimum of interference with operational activities on the airfield. It was therefore necessary that the work be well planned and cordinated to eliminate any hazard to personnel and equipment. You planned the work in a very satisfactory manner, provided the necessary equipment and trained personnel, maintained maximum safety precautions and performed the work orderly and efficiently. Your cooperation with the resident engineer and his staff and the base commander and his staff was very commendable. The result is that a hazardous but urgently needed job was completed in the minimum of time to the satisfaction of all concerned.

The base commander has expressed appreciation for your cooperation with the base for the maximum safety precautions you maintained during the entire construction period. I wish to commend you and express the appreciation of the district engineer and his staff and the resident engineer and his staff for a fine job well done.

For the district engineer:
Sincerely yours,

ROY T. DODGE,
Colonel, Corps of Engineers,
Contracting Officer.

Mr. GRIFFITH. Now, last, gentlemen, throughout the testimony there has been many questions raised about the safety feature of airfield paving. The implication once or twice at least has been that only portland cement concrete will eliminate the possibility of a plane breaking through the pavement.

I have knowledge of only two such accidents. One of those was brought up in this committee and was not familiar to me.

The other is the near accident that occurred in Pueblo, Colo., in January when the Presidential press plane, a DC-6B, with some 60 White House correspondents, newsmen, and Secret Service men ac-

companying the President on a tour of the West and Midwest—this plane while slowly taxiing across a runway broke through and was mired down. The Navy was called on for help to rescue it.

I have here the 2 newspaper articles and 2 pictures from the newspapers covering this incident. Thank you.

Mr. COURTNEY. You mean the water table was high enough to require the Navy to come in?

Mr. HÉBERT. Was that rigid pavement there?

Mr. GRIFFITH. Yes, sir.

Mr. COURTNEY. Was that a commercial airport or a military aircraft?

Mr. GRIFFITH. That is a commercial airport, and it was a commercial airplane.

(The articles are as follows:)

NEAR ACCIDENT—PRESIDENTIAL PRESS PLANE

PLANE MISHAP DELAYS WHITE HOUSE NEWSMEN

PUEBLO, January 15.—President Eisenhower's visit to Pueblo Tuesday was marred by an airport mishap which delayed 60 White House press correspondents and Secret Service men aboard a special press plane.

A 4-engined DC6–B, chartered from American Airlines and carrying the President's press corps on his drought tour, broke through the concrete apron on which it was parked at the Pueblo Airport.

The Columbine II, the President's plane, already was taxiing into position for a takeoff after the President's 33-mile tour.

THEY BOARD PLANE

Reporters, photographers, Secret Service men, and White House attachés scurried aboard their plane, which was to follow the President to Garden City and Wichita, Kans.

F. E. Illiston, captain of the huge craft, started the engines. They warmed up for a few seconds, then the captain started slowly to wheel the plane toward the runway for the takeoff.

The right front wheels moved slowly for about 20 feet. Then they broke through the concrete apron and sank hub deep below the concrete. The plane shuddered to a halt.

Seconds later, the plane's door was opened, a ramp was wheeled up. Some of the biggest names in newspaper reporting started scrambling back down to the ground shouting "abandon ship" as they emerged.

There was a mad rush for Western Union wires and telephones; then an equally mad rush for Murray Snyder, assistant White House press secretary, as the Columbine disappeared into the eastward skies, bound for Kansas.

PLANE IS OFFERED

Governor McNichols immediately offered the use of a Colorado Air National Guard plane to fly 11 correspondents on to join the President in Wichita, missing the Garden City stop.

Men with shovels, tractors, and trucks appeared to attempt to remove the bogged-down plane—which was sinking lower by the minute. Eventually, it was removed, but was held for a mechanical inspection while another plane was flown in from Dallas to pick up the stranded passengers.

The Pueblo Airport, built in 1942, does not regularly handle 4-engine craft. However, it is deemed entirely capable of bearing their weight.

LONG YEARS OF WEAR

But the combination of long years of wear, plus breakup caused by freezing and thawing, was held responsible for the mishap.

"Just think," commented one Pueblo businessman, "we get the President out here to see how dry we are—and then his press corps finds the only bog in the whole county right here at the airport."

The Columbine II was parked about 100 yards away from the stranded craft. It experienced no trouble in its cautious departure from the airport.

The 60 White House correspondents and Secret Service men aboard this charter American Airlines DC6–B plane were stranded in Pueblo for several hours Tuesday after the huge craft broke through a concrete apron at the airport and half buried its wheels.

U. S. NAVY HELPS RESCUE PLANE BOGGED DOWN ON PUEBLO AIRPORT

PUEBLO, COLO., January 16.—The Navy came to the rescue Wednesday of a transport airplane "stuck" at Pueblo's Memorial Airport.

The plane, an American Air Lines DC–6, broke through thin concrete Tuesday as it was being taxied from the parking ramp with 65 newspaper, magazine, radio and television correspondents aboard.

The correspondents were part of the party of President Eisenhower who stopped here Tuesday morning to make an inspection of drought areas south and east of Pueblo.

Jack Keeler, airport manager, said the big plane was off the regular taxiway and was moving on a section of concrete which hadn't had any work done on it since World War II.

The concrete at the spot where the wheels broke through is only 4 inches thick, Keeler said.

By Tuesday night, the airplane had sunk into the ground nearly to the top of the landing wheels.

A special salvage crew of American Air Lines arrived in Pueblo late Tuesday from Dallas to supervise the job of getting the plane out of the ground.

Wednesday morning a crew from Buckley naval air station at Denver arrived with two big rubber bags to be blown up under the planes wings.

Inflated with compressed air, the rubber bags lift against the wing surfaces and elevate the airplane until material can be placed in the holes made by the wheels.

FULL EXAMINATION

American Air Lines officials decided Tuesday afternoon that it would not be safe to fly the plane, although there was no apparent damage, until a thorough inspection had been made after it was removed from the hole.

Another DC–6 was flown to Pueblo from Dallas to pick up 45 of the correspondents and fly them to Washington, D. C. The group took off at 6 p. m. Tuesday.

A Colorado Air National Guard DC–3 was pressed into service Tuesday noon to take a group of 20 news service representatives, television network cameramen and secret service agents to Garden City and Wichita, Kans. President Eisenhower moved on to those localities after his tour here.

Russell W. Rink, Pueblo city manager, said the incident pointed up Pueblo's troubles with runway and ramp maintenance at the airport.

"The whole airport is located on a base of adobe," he said, "and it requires constant maintenance to keep the runways and taxiways in good repair."

The DC–6B press plane accompanying the President's Columbine III plane collapsed through a thin section of runway at the Pueblo airport. Work was under way Wednesday to extricate the plane from the soft soil underlying the ramp.

Mr. GRIFFITH. I think perhaps—I am not sure—that at one time the airfield had been built by the military, but its use had been discontinued.

Mr. COURTNEY. Now does that conclude your presentation for the Concrete Association?

Mr. GRIFFITH. Mr. Courtney, we still have with us today two consulting engineers that were retained by our association to look into the problem and give us their unbiased opinion and make inspections on certain bases which the Air Force graciously permitted us to visit.

Those papers have been included in the record, and those gentlemen are here today at your pleasure.

Mr. COURTNEY. Well, Mr. Chairman, the statements of the two gentlemen to whom you refer——

Mr. GRIFFITH. Mr. Warren Warden and Mr. Schuyler Hudson.

Mr. COURTNEY. Were received at the last meeting and are a part of the record.

I may say to the gentlemen that the record is voluminous and I am sure covers all of the subjects in issue. I personally think that no questions that might be asked the witnesses——

Mr. HÉBERT. Their statement is in the record as of the last hearing?

Mr. COURTNEY. Yes.

Mr. HÉBERT. All right.

Mr. COURTNEY. Thank you very much, Mr. Griffith.

Mr. Chairman, there is one matter to be supplied for the record.

A question was asked with respect to the accidents occurring on military airfields, and findings of the investigating boards which may or may not have attributed or have determined the causes, as the case may be, but where the boards' findings indicated runway problems either in whole or in part.

The accidents are reported, tabulated, and identified by field and by numbers.

This statement is here, Mr. Chairman, for the use of the committee, and as part of the record.

Mr. FERRY. I would like to comment.

I would like to have Colonel Conner comment on that, if I may, for the benefit of all concerned.

Colonel Conner.

Mr. COURTNEY. Colonel Conner and Colonel Alexander, you better——

Mr. FERRY. No. I am going to ask General Dreier—Chris Dreier—to come up.

Mr. COURTNEY. Brig. Gen. Chris Dreier——

General DREIER. Dreier—D-r-e-i-e-r.

Mr. COURTNEY. General, your official position.

General DREIER. I am Deputy Director for Real Property.

Mr. COURTNEY. Deputy Director for Real Property.

General DREIER. In the Directorate of Installations.

Mr. FERRY. And formerly——

General DREIER. Formerly was Director of Installations for General LeMay at Headquarters, SAC.

Mr. COURTNEY. Headquarters, SAC.

General DREIER. Yes.

Mr. COURTNEY. Are you an engineering officer as well?

Have you a professional background?

General DREIER. Yes, sir; I am a professional engineer.

Mr. COURTNEY. Mr. Chairman, are there any questions with respect to the accidents at this point?

Mr. CUNNINGHAM. I have no questions.

Mr. COURTNEY. Mr. Chairman, Mr. Ferry has returned with representatives of the Department of the Air Force for further responses that suggest themselves to him and for supplementing the record in the prior presentation of the Air Force.

Mr. HÉBERT. These witnesses are reappearing now as representing the Air Force in response to the committee's desire to have competent

witnesses reply to the allegations made in previous days of the hearing?

Mr. FERRY. That is correct, Mr. Hébert.

Mr. HÉBERT. That is the numerical number, and taking them down in 1, 2, 3 sequence.

Mr. FERRY. We will comment on those points which have been raised in prior testimony which we think would be of interest to the committee, to hear our views.

Mr. COURTNEY. Mr. Chairman——

Mr. HÉBERT. The committee wants to hear specifically a reply to each allegation made by the representatives of the asphalt industry. That is the committee's desire and their present invitation to have you up here today. Now, are you prepared to answer those?

Mr. FERRY. Yes, sir; we are prepared.

Mr. HÉBERT. And the committee does understand that the gentlemen now appearing for the Air Force are the competent representatives of the Air Force, and are expressing the official reply of the Air Force?

Mr. FERRY. That is correct, Mr. Hébert.

Mr. HÉBERT. And not personal opinions.

Mr. FERRY. That is correct, Mr. Hébert.

Mr. HÉBERT. Because, Mr. Ferry——

Mr. FERRY. I will assume responsibility for all of the official statements; yes, sir.

Mr. HÉBERT. Because, heretofore, as you well know, there have been certain differences in the testimony.

Mr. FERRY. That is right.

Mr. HÉBERT. Whereby under cross-examination it was learned—in particular you could not answer for the Department.

Mr. FERRY. That is right.

Mr. HÉBERT. But were only speaking for——

Mr. FERRY. That is correct.

Mr. HÉBERT. We want to hear the Department's viewpoint.

Mr. FERRY. That is correct. I am speaking for the Department.

Mr. HÉBERT. All right.

Mr. FERRY. First, Mr. Chairman, I would like to have Colonel Alexander comment on this record of accidents within the Air Force, on asphalt and on concrete pavements.

Mr. HÉBERT. Yes.

Mr. FERRY. This record has been compiled by our Air Force Safety Division, who make a record—investigate and record all accidents involving either damage to planes or to people.

This record was compiled at the request of Mr. Cunningham in order to demonstrate what is the relationship as far as numerical number and severity of accidents within our records that Colonel Alexander will comment on and summarize.

Mr. HÉBERT. That is rigid compared to flexible?

Mr. FERRY. That is right, sir.

Mr. HÉBERT. All right, Colonel Alexander.

Colonel ALEXANDER. Mr. Chairman, these figures were obtained from the Flight Safety Center of the Inspector General's Office at Norton Air Force Base, Calif.

They cover the two primary types of pavement.

The first summary on that sheet covers portland cement concrete and the combination of portland cement concrete and asphalt in the center portions of the runway.

The second portion of the summary covers the all-asphalt runways.

To read the report more accurately, we would need to know the actual exposure rate of aircraft to the two types of pavement.

Due to the many airfields of a municipal nature, and foreign airfields, we do not have an accurate number of yards of concrete and asphalt that aircraft are operating on today in the world.

So in judging this, that latter fact should be taken into consideration.

If there are any further details on any one of the specific bases or accidents, we will be very happy to go back to the flight center and obtain them for you.

Mr. CUNNINGHAM. Colonel, I notice by the report the number of accidents were 33 for rigid and the loss in dollars and cents was $2,716,000 and some odd, and in the asphalt they had 30 accidents, and the dollar loss was only $1,364,000, with the same number of aircraft destroyed in each instance, and only three less substantially damaged with the asphalt.

Now, that loss would be to the plane, I assume, that landed? Can you tell me why there would be less loss with a plane that was damaged by landing on asphalt than on concrete?

In other words, when there is a damage on concrete, is it more severe an accident than if it happens on flexible? Do you have any explanation for it?

It isn't evidently the difference between the cost of concrete and asphalt. The damage is to the plane.

Colonel ALEXANDER. That is correct, sir.

No, sir; I don't have any explanation as between the two types.

Mr. BATES. Is it the cost of the plane?

Colonel ALEXANDER. It is the cost of the plane; yes, sir.

Mr. BATES. Well, that is the answer; isn't it?

Colonel ALEXANDER. No, sir.

I thought his question——

Mr. CUNNINGHAM. Why would more expensive planes land on concrete than on the other?

Is there a reason for that?

Colonel ALEXANDER. No, sir.

Mr. CUNNINGHAM. I don't think that is any answer, as to the cost of the plane.

Colonel ALEXANDER. It is the cost to the plane——

Mr. COURTNEY. It is the damage to the plane.

Colonel ALEXANDER. The value——

Mr. CUNNINGHAM. That is just it. Here are approximately the same number of accidents on two different airfields. The cost of the damage on one type of airfield is double, more than double, or about double, that of the other. Unless you had an entirely different kind of plane where the damage could be greater on one than the other—it runs right through and that isn't to me a satisfactory answer. There is some other reason for it.

Colonel ALEXANDER. I think the only way we could answer your question accurately would be to get the dollar cost of each one of those accidents and the degree of damage to the aircraft.

In other words, some of these accidents may be of a minor degree, whereas, another accident may cost $1 million. One accident may cost $1 million.

Mr. CUNNINGHAM. That is right.

Colonel ALEXANDER. And the 30 of them might not cost but half a million.

Mr. CUNNINGHAM. But the consistency of the differential in your report there tells me that there might be a reason why when there is an accident on one kind of pavement, the damage is greater than a similar accident on another kind of pavement, and I wonder whether or not that has been gone into.

I think it is very vital for this committee to know.

Colonel ALEXANDER. We will certainly go back to our flight safety people, and pose that question to them, and furnish you their reply.

Mr. CUNNINGHAM. If it was just one plane that caused all the differential——

Colonel ALEXANDER. Yes, sir.

Mr. CUNNINGHAM. I could understand it. But here is more or less a consistency, as I see your report, in going through there, with approximately the same number of accidents.

Colonel ALEXANDER. Yes, sir. We will be glad to have the flight safety people search the record.

Mr. HÉBERT. Mr. Osmers?

Mr. OSMERS. Colonel, do you think that it is possible from an engineering standpoint to state that a certain accident had as a primary or contributing cause the runway?

Colonel ALEXANDER. Let me see if I understand you, sir.

Mr. OSMERS. Well, you have so many variables.

Colonel ALEXANDER. Yes, sir.

Mr. OSMERS. You have wind.

Colonel ALEXANDER. Yes.

Mr. OSMERS. You have defective brakes. You have a lot of different—you could even have a human failure on the part of the pilot.

Do you think it is possible to cut right down through all of your accidents and come up with figures that really have meaning as to runways in connection with these accidents?

Colonel ALEXANDER. I think it is highly doubtful, sir.

Mr. OSMERS. So do I. It just doesn't seem to me that these figures—there are so many factors. First, you would have to know whether we are talking about the landings and takeoffs of 5,000 planes on concrete and 1,000 on flexible. I think if the figures do anything, they probably mislead us.

Colonel ALEXANDER. That was my first statement, that led into that area, was that the exposure rate of the aircraft to the two types of pavement really gives the credit of the ability of one pavement over the other to be more accident free.

Mr. CUNNINGHAM. But, Colonel, you give on your report here substantially the same reason for the accidents on each one.

Colonel ALEXANDER. That is correct.

Mr. CUNNINGHAM. Poor braking action on wet runways, and so on. That is about the same to me.

Colonel ALEXANDER. Yes, sir.

Mr. CUNNINGHAM. I just wondered if you have any explanation at this time? I don't want to belabor the question.

Colonel ALEXANDER. No, sir.

I would have to get details from the Flight Safety Center on those accidents.

(The accident report is as follows:)

AIRCRAFT ACCIDENTS WHICH WERE ATTRIBUTED TO RUNWAYS AS PRIMARY OR CONTRIBUTING CAUSE FACTORS FOR PERIOD JANUARY 1, 1954, THROUGH APRIL 1957

(Furnished by the Office, Inspector General, USAF)

A. Concrete or combination of concrete and asphalt runways

Number of accidents	33
Aircraft destroyed	3
Substantially damaged	30
Dollar loss	$2,716,356

Cause

1. Poor braking action on wet runways, 30 accidents:

AIRFIELDS

Boulhaut, Morocco	K-2 Air Base, Korea
Birmingham Municipal Airport, Ala.	Kinross Air Force Base, Mich.
Bitburg Air Base, Germany	Mitchel Air Force Base, N. Y.
Ping Tung Air Base, Formosa	Lajes Field, Azores
Aviano Air Base, Italy	Brookley Air Force Base, Ala.
Ashiya Air Base, Japan	Hensley Field, Tex.
Amon Carter Field, Tex.	Baier Field, Ind.
Landstuhl Air Base, Germany	England Air Force Base, La.
Dow Air Force Base, Maine	Langley Air Force Base, Va.
Goose Air Force Base, Labrador	Robins Air Force Base, Ga.
Geiger Air Force Base, Wash.	Dobbins Air Force Base, Ga.

Type aircraft.—B-57, B-25, F-94, F-84, T-33, F-86F, F-86D, B-26, C-54, F-80, F-110-D, F-84E.

2. Irregular runway surface, 3 accidents:

AIRFIELDS

Hensley Field, Tex.	Berry Field, Tenn.

Type aircraft.—F-80, T-33.

B. Asphalt runways

Number of accidents	30
Aircraft destroyed	3
Substantially damaged	27
Dollar loss	$1,364,342

Cause

1. Poor braking action on wet or deteriorated runway surface, 22 accidents:

AIRFIELDS

Adams Field, Ark.	Semback, Germany
Wethersfield Air Base, England	Palm Beach Airport, Fla.
Toul-Rusiere Air Base, France	Amarillo Air Base, Tex.
Eglin Air Force Base, Fla.	Galena Air Base, Alaska.
Hickam Air Force Base, T. H.	Gila Bend Auxiliary Field, Ariz.
Hamilton Air Force Base, Calif.	Lakenheath Air Base, England
Moody Air Force Base, Ga.	Sturgate Air Base, England
Miami International Airport, Fla.	Greater Pittsburgh Airport, Pa.
Nellis Air Force Base, Nev.	

Type aircraft.—F-80, F-84-F, T-33, C-97, F-86H, B-47, F-84G, B-17, F-86F, F-94C

2. Irregular runway surface contributing to porpoising, 6 accidents:

AIRFIELDS

Eglin Air Force Base, Fla.
Holloman Air Force Base, N. Mex.
Logan Air Force Base, Mass.
Barstow Airfield, Fla.
Philadelphia International Airport, Pa.

Type aircraft.—F–100D, T–33, F–94A

3. Irregular runway surface caused aircraft to become momentarily airborne resulting in premature gear retraction, 2 accidents:

AIRFIELD

Newcastle County Airport, Del.

Type aircraft.—F–94C.

Mr. CUNNINGHAM. That is all, Mr. Chairman.

Mr. OSMERS. As a practical matter, Mr. Chairman, I wonder if the colonel feels that there has been some demonstrated superiority of one type of runway over the other insofar as these accidents have been concerned, assuming that both runways are in good condition?

Colonel ALEXANDER. In my discussions with operational type people in the Air Force, they do give greater credit to rigid pavement as far as visibility goes. They express in landings, when they are coming in on a dark and rainy night, that a black surface appears as a hole to a pilot.

There have been comments to the effect that——

Mr. OSMERS. This would also make it easier for the enemy to find, wouldn't it?

Colonel ALEXANDER. Yes, sir, if it was in a combat zone; yes, sir.

Mr. OSMERS. Well, aren't you dealing mostly, Colonel—if I might ask him, Mr. Chairman?

We are concerned primarily with the large bomber-type aircraft. That is what leads us to this investigation here. And don't you think that for the most part you are going to land planes of that type largely with instruments?

Colonel ALEXANDER. Oh, no, sir.

Mr. FERRY. No, sir.

Mr. OSMERS. No?

Colonel ALEXANDER. No, sir.

Mr. OSMERS. You are going to come in visually in the dark.

Colonel ALEXANDER. In all kind of weather.

In other words, we have all kinds of runways and all kinds of flying capability.

Mr. MILLER. Does the gentleman yield?

Mr. OSMERS. Yes.

Mr. MILLER. Colonel, aren't you up against almost the same situation when you drive a car?

There are times when a white concrete pavement is much better and there are other times when the dark pavement is better on a bright sunshiny day or when the snow is on the ground and you can't see the center marker, as white wouldn't do you very much good. At night, it is fine. In daytime it isn't. But the condition changes so rapidly. I would hesitate to say that you should have all white or all black pavement. Isn't that a good deal the same in landing on an airfield? There are times perhaps when landing into the bright sun with a black pavement would be much better than a white pavement?

Colonel ALEXANDER. I am not a pilot, Mr. Miller, but I think that what you have to say has some merit.

Mr. MILLER. There is that factor.

Colonel ALEXANDER. Yes, sir.

Mr. MILLER. And it is one that varies so much that you would have to have some way of changing the color of those pavements from time to time to meet the local conditions at a given time in the day.

Mr. OSMERS. Of course, Mr. Chairman, if you followed the argument of visibility, that means on any coral situation for example, where you had a white background, you would then, eliminating all other factors, use a flexible type pavement because it would be dark and therefore easier to see in a lighter background, in a snow background or a coral background.

Mr. MILLER. Conditions could change in the same place from hour to hour, and from season to season.

Mr. FERRY. May I——

Mr. MILLER. May I ask this question, Mr. Chairman?

Mr. HÉBERT. Yes, sir.

Mr. MILLER. Just glancing down through here, I noticed in the first group a good many of them are outside the continental limits of the United States.

Are those airfields that were constructed outside the continental limits—have they always been constructed up to the high standard, that is, has it been possible to construct them up to the high standard that we have here in the United States?

Weren't some of these put in under sort of a crash program?

Mr. FERRY. I will have to answer that in the most general terms, sir, because we do not talk of specific fields.

Mr. MILLER. No——

Mr. FERRY. But, generally, on American fields——

Mr. MILLER. I didn't say specific fields. I said outside of the United States.

Mr. FERRY. Generally, on our fields constructed under the supervision of our construction agents, the Corps of Engineers——

Mr. MILLER. And United States materiel

Mr. FERRY. And United States materiel, are of higher quality than foreign fields that have been constructed not necessarily to our standards, and not necessarily to our specifications, and without the supervision of our constructing agents.

Mr. MILLER. We were in a hurry and, as a matter of expediency, we let the bars down. I have in mind one field outside of the United States, that I happened to be in the first plane that landed there. I know that field is not up to the standards. It is one of the fields that we don't have full control of. We would like to have it up to the right standard. I think—I didn't notice whether that particular one is listed here or not.

Mr. FERRY. I don't think this accident report can be considered conclusive evidence either way, in favor of either concrete or asphalt, as far as safety is concerned, and I think it would be a mistake to put too much stress on this point. I think it becomes a subsidiary point in this discussion here, which is wandering, perhaps, a little far from the basic essential of it.

Mr. MILLER. As I look at it, I am inclined to agree with you.

Mr. HÉBERT. All right.

Mr. FERRY. May I call now on General Dreier, who, as he has stated for the record, was the installation engineer for SAC out in Omaha

and as such was the engineer in charge of supervision, inspection, programing, and such, for General LeMay's SAC outfit? The statements have been made that General LeMay had a preference as between rigid and flexible pavings for SAC bombers. I will ask General Dreier, who has been intimately connected with this, to speak, of his own knowledge, of General LeMay's position on this matter.

Mr. HÉBERT. I think——

General DREIER. I think——

Mr. HÉBERT. Unless General LeMay has told the general what to say, I don't think——

Mr. FERRY. No, sir.

Mr. HÉBERT. Then it is an opinion, and General LeMay would be the best witness to testify to what he thinks.

Mr. FERRY. I hesitated to bring the the general here today, because I had the spokesman for him who was intimately connected with the matter for several years.

Mr. HÉBERT. Unless General LeMay told him specifically what to say, I don't think it is competent testimony at this time.

Mr. FERRY. Can I ask General Dreier, in that case, to state his own view on the subject, as installations engineer for SAC?

Mr. HÉBERT. His own view, certainly.

General DREIER. I can say that General LeMay has told me very emphatically that he has a preference for rigid airfield pavement, and he did want portland cement concrete pavements for his airfields wherever it is possible.

Mr. HÉBERT. In all areas?

General DREIER. He gave me specific instructions along those lines.

Mr. HÉBERT. In all areas?

General DREIER. In all airfield areas, yes, sir, for airfield pavements. I differentiate between airfield pavement and highways or roads, and streets, and so forth.

Mr. HÉBERT. So, in other words, you are reexpressing what you say General LeMay told you—it certainly would be noncritical areas, as far as he is concerned. He just wants concrete, period.

General DREIER. He has the feeling that wherever his aircraft go or are parked are critical areas as far as he is concerned.

Mr. HÉBERT. That is specific. He just wants concrete, period.

General DREIER. He wants concrete; that is right.

Mr. CUNNINGHAM. I think that has been obvious from the beginning, has it not, Mr. Chairman?

Mr. HÉBERT. It has.

Mr. CUNNINGHAM. That the Air Corps prefers——

Mr. HÉBERT. Air Force, Mr. Cunningham.

Mr. CUNNINGHAM. Air Force; yes.

Mr. FERRY. Mr. Chairman, this entered in the record not to be argumentative or otherwise. Merely, it is a part of the discussion which took place as to General LeMay's preference in the matter, and I thought it would be well to clarify it.

Mr. HÉBERT. I think it has been clarified, Mr. Ferry.

Mr. FERRY. Thank you very much, sir.

Mr. HÉBERT. You want alcohol, champagne, or whisky; that is all. General LeMay wants champagne, period.

Mr. FERRY. Yes.

Mr. HÉBERT. All right; let's proceed, Mr. Courtney.

Mr. COURTNEY. One question of General Dreier. Of course, the statement you make is based upon the premise that the design is adequate to support the load, regardless of the surfaces; isn't that right?

General DREIER. Well, obviously, that follows; that is right.

Mr. COURTNEY. Yes, sir. We want to be sure we have an adequate design.

General DREIER. That is correct.

Mr. COURTNEY. In view of the accident rate that has been talked about. That is all, General.

Mr. FERRY. Now, I have with me—thank you, General Dreier. Would you stay around?

Mr. HÉBERT. General.

Mr. FERRY. General, one moment.

Mr. HÉBERT. The opinion you just expressed of what General LeMay has told you—do you concur in that?

General DREIER. Very definitely; yes, sir.

Mr. HÉBERT. That is right. You wouldn't be a deputy if you didn't concur in the chief's statement.

Mr. COURTNEY. So it is an easy decision, isn't it?

Mr. FERRY. May I proceed?

Mr. HÉBERT. Let us get off the record until I get the record here I want in front of me.

(Discussion off the record.)

Mr. HÉBERT. I am referring to the Kelly test——

(Discussion off the record.)

Mr. HÉBERT. On the record. Now, I am addressing myself to the specific observations and allegations made in connection with the much-discussed Kelly test.

(Mr. Wellborn's full report, as covered by exhibit D–2 on the Kelly test, is as follows:)

SUMMARY REPORT ON THE STATUS OF FLEXIBLE PAVEMENTS FOR HEAVY MILITARY AIRCRAFT

By Arvin S. Wellborn, chief engineer, the Asphalt Institute

Preface

In recent weeks, elements of the engineering press, armed with insufficient information, have attempted to appraise the status of flexible pavements for modern military airfields. These appraisals have been based on incomplete data from a single pavement test conducted during the summer of 1956 at Kelly Air Force Base in Texas.

It is the considered judgment of the Asphalt Institute, after an extensive review of all the facts, that the test at Kelly AFB could have ended no other way than distress in the asphalt section. A combination of factors, readily understood by asphalt technologists, doomed the pavement to failure before the first test loading was placed on it.

Further, since the suspension of testing at Kelly, new pavement test-loading conditions have been established that are totally unprecedented in the history of pavement design. In fact, the new conditions have removed pavement design entirely from the realm of contemporary paving technology and placed it in a new and uncharted dimension.

It must be borne in mind that flexible pavements today are serving fully the requirements of our heaviest bomber aircraft at many Air Force installations. Consequently, we must apply very critical judgment to the results of the Kelly test and ask: Why failure here?

Because the accounts of the Kelly AFB test have lent themselves to gross misinterpretation, seriously injuring the reputation of all flexible pavements, this engineering examination of the situation must be offered.

History

Some elements in the Air Force long have expressed dissatisfaction with flexible pavement and, in 1954, announced they were specifying concrete paving for those critical areas subject to jet after-burner blast and excessive fuel spillage which might have a harmful effect on asphalt pavements.

In December of 1955, the Secretary of Defense authorized the Air Force to extend the term "critical" to include all "primary use areas," including those areas not subject to this spillage and heat blast. In defense of its new policy, the Air Force claimed failures in flexible pavements wherever the channelized traffic of the new B–47 bombers was applied. Seven heavy bomber bases were cited where such failures were alleged to have occurred.

Granted permission to inspect these fields, the Asphalt Institute determined that only 3 of the 7 airfields showed distress that could not be corrected with normal maintenance procedures. In the three cases of severe distress, the cause was traced to faulty design or construction. In one instance, elementary drainage had been largely neglected. At another base, it was learned that distressed areas had not been compacted before paving. In only one case was the distress traced directly to the asphaltic concrete surface and in this instance the pavement did not meet the design requirements. In most cases, proper maintenance operations were virtually nonexistent.

The United States Corps of Engineers expressed their confidence that asphalt pavements are entirely capable of withstanding the channelized traffic and supported this position with data from test panels constructed at their Flexible Pavements Branch at Vicksburg, Miss. The Air Force declined to accept this as conclusive evidence and requested that a demonstration-type section be constructed under normal contract conditions. Kelly Air Force Base was selected.

Existing criteria were applied to the test sections, except that the test-loading requirements were increased from 1,500 to 30,000 coverages of 100,000-pound dual-wheel loads under accelerated traffic and at pavement temperatures in excess of 90° F. (It should be noted that this increase in coverages was a twentyfold increase at high temperatures for flexible pavement. At the same time the increase in coverages for the rigid section was only sixfold.)

During the construction of the pavement, it became apparent to the Asphalt Institute, serving as an observer, that the paving mix required by Air Force mandate was clearly too rich to sustain the accelerated test traffic immediately after construction, in the midsummer Texas heat. Any experienced asphalt technologist knows how an overrich asphalt mix will behave.

When the institute's worst fears were realized and the pavement showed early distress, the asphalt industry proposed that the faulty test section be removed and reconstructed with a more appropriately proportioned mixture. The Air Force declared itself satisfied with the results and ordered the tests terminated—although normal procedure by experienced engineers under these circumstances would have been to modify the mix, making it leaner, and retest.

Analysis of the test

For reasons not entirely clear, the test called for 30,000 coverages at accelerated rate of the 100,000-pound gear load at pavement temperatures not lower than 90° F.—although it is apparent that these extreme conditions will never be encountered in actual airfield operations. The existing mix design criteria then in use by the Corps of Engineers called for 1,500 coverages of accelerated traffic under high-pavement temperatures. Pavements designed by these criteria are today carrying heavy bomber traffic without distress.

The decision to step up the tempo of the accelerated traffic in the hottest summer months must be recognized as an unrealistic requirement. This accelerated traffic coverage was scheduled at a rate of 500 coverages per day, which is the equivalent of a full month's usage of the pavement under prototype traffic. To withstand this type of testing it is only logical that the asphalt mixture should have been designed with a proportionately leaner asphalt content. This was recognized by the Corps of Engineers. However, they were not given the opportunity to adjust the mix and retest.

Let us summarize the curiously mixed factors that were jammed into the test equation:

1. The Air Force required the asphalt pavement to be designed on the basis of criteria established with 1,500 coverages of accelerated test traffic at high temperature.

2. Test traffic applied at Kelly, however, was 30,000 coverages, or 20 times the amount on which the pavement mix design criteria were based.

3. All test traffic was applied at Kelly under high pavement temperature conditions, a situation not encountered in actual airfield pavements. As any technologist knows, this is abnormally severe for asphalt pavement and not similarly severe for rigid pavement.

4. Spacing of test traffic load wheels was 20 feet instead of approximately 40 feet, as for the B–47 aircraft. This factor may have eliminated for all practical purposes rebound and recovery factors and induced interfacial stresses of a high order of magnitude.

5. So-called antistrip additive was placed in the hot asphalt mixture. This procedure is contrary to the published policy of the Asphalt Institute and could have contributed to the distress that developed.

In effect, the Kelly test was no test at all. This was recognized by an official of the Corps of Engineers who, at a conference of the interested parties, later declared the asphaltic concrete surface placed on the demonstration test section at Kelly AFB was, in his opinion, still the best flexible airfield pavement for prototype traffic and a pavement just a little bit leaner would have carried 30,000 coverages of accelerated traffic without failure.

In all probability, the pavement built at Kelly, under any but the special and peculiar circumstances of the test, would have demonstrated a capacity to serve the requirements of our heaviest bombers without distress during the normal life expectancy of the pavement.

One thing the aborted Kelly test did demonstrate: Base and subbase for flexible pavement can be built by normal contract procedures that will withstand accelerated traffic of these heavy wheel loads, and perform to the complete satisfaction of the most exacting engineer. In the confused accounts of the Kelly episode this is a fact that has been obscured.

New test conditions

Since the Kelly test, the Asphalt Institute has learned that new test loading conditions have been established which are not only totally without precedent but far exceed the limits of present engineering knowledge. The Corps of Engineers have embarked upon a program of testing pavements under 30,000 coverages of test loads of 325,000 pounds on twin tandem gears (81,250 pounds per tire) at tire pressures of 325 pounds per square inch and at pavement temperatures not lower than 90° F.

These wheel assembly test loads are approximately three times those of the B–47 bomber. They are far in excess of landing gear loads of any civil air transport, propeller or jet, existing or contemplated.

Designing any type of pavement to meet these test loads is an extrapolation into the unknown which can be established only through research. Knowledge must be gained through continued testing. Yet, testing by the Corps of Engineers has been suspended because no further funds have been allocated by the Air Force.

The Asphalt Institute believes this is a problem of vital concern to the national defense and the national economy. It feels that adequate research funds should be allocated from the defense budget if we earnestly hope to preserve properly engineered construction for our Military Establishment. With $43 billion of a proposed $72 billion national budget earmarked for the Department of Defense, the lion's share of which will be expended for air defense, it seems reasonable to expect a modest appropriation for continued airfield pavement research.

The institute will, of course, continue its own research in this direction. Meanwhile, however, if there is any construction method which has proved it can meet these new test conditions, the institute wishes to propose this interim solution:

The pavement distress under these increased test loads occurs exclusively in a narrow track along the centerline of the runways and taxiways. Consequently, as an interim solution, it is suggested that the Corps of Engineers and the Air Force confine to the ends and center strips of its runways and taxiways whatever special construction may be required to handle this unprecedented channelized traffic. It is further suggested that the remainder of the runways and taxiways continue to be constructed of asphalt pavements because of their proven adequacy and economy.

This, we repeat, is offered as an interim construction policy in a period of accelerated transition, both in aircraft and pavement design.

It is pertinent to point out that 7 of our 10 busiest civilian airports are served by asphalt pavements. Nor does Commissioner James T. Pyle, of the Civil Aero-

nautics Administration, anticipate any need to make drastic changes in pavement design to accommodate tomorrow's jet transports. He has expressed the conviction that today's runway pavements, with some extensions where indicated, will be adequate for the transports now in design stage.

The false analogy

The Asphalt Institute is seriously disturbed by the misleading interpretation being assigned to the abortive and unrealistic pavement test at Kelly Air Force Base. The erroneous conclusions are being applied, frequently in all innocence, to highway construction.

Even if it were a valid test, which it was not, the Kelly Air Force Base test could not yield data that would apply to highway paving needs. The extreme range of tire loads rules out even the remotest relationship. The maximum legal tire load permitted on our highways lies within the 5,000-pound-6,000-pound range. The Kelly test used a 50,000-pound tire load.

Further, highway truck tire pressures average 70 p. s. i.; aircraft tire pressures used in the Kelly test were 200 p. s. i.

In the last 10 years the technology of asphalt paving has made tremendous strides. Whether a flexible pavement can be designed and built to meet the almost incredible test loadings recently introduced at Vicksburg (325,000 pounds at 325 p. s. i., and so forth) is a question that only time and patient research can answer. Whether any construction can pass the test is an interesting matter for conjecture.

Meanwhile, thoughtful paving engineers will recognize the distinction between two very dissimilar pavement criteria (military bomber requirements versus civil airfield and highway needs) and will refuse to be led astray by a false analogy.

Mr. HÉBERT. Specifically, Mr. Wellborn made this statement. I am directing the question to the Kelly tests—

The Air Force required the asphalt pavement to be designed on the basis of criteria established with 1,500 coverages of accelerated test traffic at high pavement temperature.

Is that correct?

Colonel ALEXANDER. No, sir.

Mr. HÉBERT. All right. It is your statement.

Colonel ALEXANDER. Mr. Chairman, Air Force Headquarters and OCE prepared a statement which comments on the exhibit that Mr. Wellborn put in this folder that he has handed to you.

We have answered paragraph by paragraph every one of the allegations made on this test. This is a a joint paper that I have.

Mr. COURTNEY. Are there copies available, Colonel?

Mr. FOGO. Do you have some copies of them?

Colonel ALEXANDER. Let me see.

Mr. FERRY. Off the record, Mr. Hébert——

Mr. HÉBERT. Off the record.

(Discussion off the record.)

Mr. HÉBERT. I recognize that you all must have been working pretty zealously.

Now, Colonel, I repeat the question. What is your answer to it?

Colonel ALEXANDER. Mr. Chairman, reading the statement that we answered specifically—it is parallel to that, but I would like to read the one which is extracted from his exhibit.

Existing criteria were applied to the test sections, except that the test loadings requirements were increased from 1,500 to 30,000 coverages of 100,000 pounds dual wheels loads under accelerated traffic and at pavement temperatures of 90° F. (It should be noted that this increase in coverages was a twentyfold increase at high temperatures for flexible pavement. At the same time, the increase in coverages for the rigid section was only sixfold.)

That was Mr. Wellborn's statement.

The comment of the Air Force and the Corps of Engineers:

The comparison between the increase in coverages from 1,500 for flexible pavements and for rigid pavements to 30,000 coverages is considered to be immaterial, although the existing criteria were based on accelerated traffic tests carried to only 1,500 coverages, it is considered that the criteria were adequate for 5,000 coverages in an accelerated traffic test. There was no test requirement that the traffic should be applied when pavement temperatures were in excess of 90° F. However, asphalt concrete pavements should perform adequately at this temperature. The pavement temperatures of the asphalt pavement during the application of the traffic coverages (May and June of 1956) ranged from 67° F. to a maximum of 131° F. A substantial portion of the traffic was applied when the pavement temperatures were in excess of 90° F.

Mr. HÉBERT. Now, Colonel.

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. Mr. Wellborn said:

The Air Force required the asphalt pavement to be designed on the basis of criteria established with 1,500 coverages of accelerated test traffic at high pavement temperature.

Is that correct or not correct?

Colonel ALEXANDER. That is not correct.

Mr. HÉBERT. You did not instruct the engineers to build this test strip under this criteria, this statement?

Colonel ALEXANDER. We did not specify any number of coverages to the Corps of Engineers for the test strip.

Mr. HÉBERT. What did you tell them to do when you told them to build a test strip?

Colonel ALEXANDER. Let's see. I believe I have—well, I will summarize. I think I have the actual letter to the Corps of Engineers.

Mr. HÉBERT. It is very simple: Did you or did you not tell them to build the airstrip on certain criteria?

Colonel ALEXANDER. We asked them to build a demonstration test of flexible and rigid pavement that would support channelized traffic, period.

Mr. HÉBERT. And you did not specify 1,500 coverages?

Colonel ALEXANDER. No, sir.

Mr. HÉBERT. All right.

Let's go to the second one. Let me ask there: In connection with that, what intent did you have on your centralized traffic, or concentrated traffic? How many coverages did you intend?

Colonel ALEXANDER. Thirty thousand, sir. That was an agreed coverage figure by the Corps of Engineers and the Air Force.

Mr. HÉBERT. Well, now, I have to call your attention to the testimony, as I recall it, that—it was Foster testifying for the engineers, who testified that they constructed the flexible to take 1,500—rather, the maximum was 1,500 coverages, but in order to play it safe they constructed what they thought would take 30,000 coverages, and it did not take the 30,000 coverages. I recall that testimony.

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. Now, do you want the committee to understand that the Air Force specifically told the engineers to construct the flexible pavement to take 30,000 coverages?

Colonel ALEXANDER. No, sir; I don't want to beg the question, Mr. Chairman.

Mr. HÉBERT. I don't want to beg it, either. I want to get an answer.

Colonel ALEXANDER. We asked the Corps of Engineers to build us a demonstration test track proving that their current design for channelized traffic was adequate. We did not go into the number of coverages for the test track.

In previous discussions with the Corps of Engineers on related subjects, we had agreed that the probable life of a pavement would go up to 30,000 coverages.

But going back, when we asked them to build the Kelly test track, we specified no coverages. We said channelized traffic for both types of pavement.

Mr. COURTNEY. Then you knew that 30,000 coverages would be the test that would be applied?

Colonel ALEXANDER. That is correct.

Mr. HÉBERT. And did you know that the flexible was not constructed to take the 30,000 coverages, except as a maximum; that it was an average coverage; that in reality it was constructed basically to take the 1,500 coverages?

Colonel ALEXANDER. No, sir; I didn't know that. The Air Force didn't know that.

Mr. HÉBERT. So you started off by making a test on something you didn't know what its maximum capability was?

Colonel ALEXANDER. No, sir. We asked the Corps of Engineers to build a demonstration test track to carry channelized traffic. And the details of the thickness, of the asphalt content, of the gradations, of the base course—all of those things were the prerogative of the Chief of Engineers.

He is responsible.

Mr. HÉBERT. Then if the engineers testified that they constructed the flexible portion of the test strip on the basis of 1,500 coverages, with an estimated 30,000 coverages, you, the Air Force, were not getting what you thought you were getting?

Colonel ALEXANDER. That could be.

Mr. HÉBERT. That is all I want to know. But you didn't tell them to do it and if there was a difference in the construction, it was the engineers who failed to give you what you thought they were giving you?

Colonel ALEXANDER. That is correct.

Mr. HÉBERT. All right.

It is very simple if you answer the question.

The second observation:

> Test traffic required at Kelly, however, was 30,000 coverages, or 20 times the amount on which the pavement mix design criteria were based. Therefore, for these conditions, the asphalt mixture was clearly too rich.

Do you have any comment on that? I think you answered it, but I ask you again. You answered that you expected 30,000, yet they say it was constructed only to take 20 times less than that. Therefore it was an overexposure to the actual construction of the strip as related to flexible?

Colonel ALEXANDER. Yes, sir; I have just testified——

Mr. HÉBERT. I say you have.

Colonel ALEXANDER. Yes.

Mr. HÉBERT. I am just repeating it to keep it in line.

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. That is correct. So, again, you all were testing it then on a strip which was not adequate for the test that you contemplated?

Colonel ALEXANDER. That wasn't to the knowledge of the Air Force, Mr. Hébert.

Mr. HÉBERT. I am not saying it is to your knowledge.

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. It was not to your knowledge?

Colonel ALEXANDER. No, sir.

Mr. HÉBERT. I am talking what the facts were. You did not know that strip was not adequate to take the 30,000 coverages?

Colonel ALEXANDER. Mr. Hébert, I believe Mr. Foster testified that he and Mr. Turnbull had a great deal to do with the design of that track. This could be verified in the record.

Mr. HÉBERT. That is correct.

Colonel ALEXANDER. To the best of my recollection, he stated that that track was designed to the best knowledge that they had to carry 30,000 coverages, and they fully thought that it would carry 30,000 coverages.

Mr. HÉBERT. We won't quibble.

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. The testimony was that it was constructed under direction for 1,500 coverages, but in order to play it safe they, on their own accord, constructed or designed what they thought would carry 30,000, which did not carry the 30,000. I mean the fact is it did not carry the 30,000.

Colonel ALEXANDER. But according to Mr. Foster's testimony, it was designed to carry 30,000.

Mr. HÉBERT. That he thought would carry 30,000. He didn't play it that safe, now, because the mix, it was testified, was obviously too rich, and which I think was admitted in the testimony, too?

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. If they had gone ahead and constructed this strip for 30,000 at the time instead of the 1,500 coverages at the minimum, a different type of mix would have been used and they would have probably attempted to cover 50,000 or 60,000 coverages as a maximum, using the minimum of 30,000. Here they used the minimum of 1,500, with the estimated hope that it would carry 30,000. Now—go on.

Colonel ALEXANDER. Mr. Chairman, the statement that the mix was too rich is a statement that could only be made after the test was run. When that mix was made and the bitumen content was determined, it was determined to be what was required to carry 30,000 coverages.

Mr. HÉBERT. All right.

Colonel ALEXANDER. So statements which now come up and say that the bitumen was in excess can only be made subsequent to that test. They could not be made prior to the test by anyone.

Mr. HÉBERT. That is correct.

That will bring up a later point, that no attempt was made to put a flexible strip in there with a less rich mix in order to cover the test. I mean the testimony shows that very clearly, Colonel.

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. As a matter of fact, as soon as the pavement failed, boom, it went out. You didn't find whether you could get a mix to carry the 30,000; isn't that a fact?

Colonel ALEXANDER. We didn't find it out at Kelly, sir, but we did find it out at the flexible laboratory.

Mr. HÉBERT. I don't care where you found it out. The fact is you could get a mix to carry the 30,000?

Colonel ALEXANDER. The testimony of the Corps of Engineers was to the effect, as I recall, that they have developed pilot-test sections which did carry the 100,000-pound load when they reduced the bitumen.

Mr. HÉBERT. All right.

Colonel ALEXANDER. And that test section was started in June, the same June in 1956, that the Kelly test failed.

Mr. HÉBERT. All right.

You have not subsequently attempted to determine that the flexible can carry the 30,000 load. Now, this is a fact; isn't it?

Colonel ALEXANDER. No, sir.

Mr. HÉBERT. No, sir?

Colonel ALEXANDER. I just stated, Mr. Hébert, that in June of 1956, the same June that the Kelly track failed, pilot-test models, that is, panels, were constructed at Vicksburg, and they were rolled with the same loading that was imposed at Kelly, and during the same fall of 1956 those panels had carried approximately 30,000 coverages. As I recall, that is in Mr. Foster's testimony.

Mr. HÉBERT. That is correct.

But the Air Force has not conducted any experiment similar to the Kelly test to indicate that the flexible pavement can carry the 30,000 coverages?

Colonel ALEXANDER. That is correct; we haven't done it similar to the Kelly test. That part is correct.

Mr. HÉBERT. All right.

Colonel ALEXANDER. But it has been carried on at the laboratory.

Mr. HÉBERT. All right.

Colonel ALEXANDER. Yes, sir.

Mr. HÉBERT. Then is the Air Force willing to accept the premise that flexible pavement can carry the 30,000 coverages now?

Mr. FERRY. No, sir.

Colonel ALEXANDER. No, sir.

Mr. HÉBERT. Not until you have a test?

Colonel ALEXANDER. Not until the Chief of Engineers tells us so, sir.

Mr. FERRY. And demonstrates it by a test.

Mr. COURTNEY. May I ask a question, Mr. Chairman?

Mr. HÉBERT. Surely.

Mr. COURTNEY. Mr. Chairman, the question suggests itself right there: Assuming the Chief of Engineers does tell you that he has a pavement which will meet a 30,000 test, or meet the criteria that we are talking about now, would the Air Force accept that recommendation and incorporate it in your criteria?

Mr. FERRY. That is a hypothetical question, sir.

Mr. COURTNEY. Precisely. Of course it is a hypothetical question.

Mr. FERRY. Within the testimony here, the Chief of Engineers, represented by General Wilson, says he can't give us a design that will stand a flexible paving.

Mr. COURTNEY. No; but I am asking you the hypothetical question which suggests itself because of your testimony at this point and because of General Wilson's testimony, that they were on the verge of a breakthrough.

Mr. FERRY. As soon——

Mr. COURTNEY. Let me finish the question.

Mr. FERRY. Right.

Mr. COURTNEY. Assuming the breakthrough is completed and the engineers tell you they can construct in that fashion to meet those loads with flexible pavements, will you accept that as a criteria in the Air Force?

Mr. FERRY. I will answer you with complete frankness, sir. As soon as the Chief of Engineers tells us he has a flexible pavement that will stand our criteria for heavy bombers, of 30,000 passages——

Mr. COURTNEY. Whatever it may be.

Mr. FERRY. Whatever it may be, and demonstrates same to us by a test section where we can see the actual results, and it is not purely laboratory results, we will gladly and with the greatest of pleasure accept that criteria. We would like to get into it.

Mr. CUNNINGHAM. Pardon me. And in doing that, Mr. Ferry, you will take into consideration the loss to human life?

Mr. FERRY. Sir, I do not—I will answer you yes, if there is any conclusive figures bearing upon that point to show a difference of accident rate, fatality rate between flexible and rigid. Such has never been demonstrated.

Mr. CUNNINGHAM. Mr. Chairman, I don't see how you can ask for a fairer statement.

Mr. HÉBERT. I will read to you what Mr. Foster did say.

Simultaneously with the Kelly test, a section was tested at Vicksburg with similar mixes, but with a range of bitumen contents. Mixes placed at optimum bitumen content, the same as used at Kelly, also rutted, but those places with 20 percent less asphalt than optimum successfully carried 30,000 coverages of simulated B–47 loading. As a result of these tests and the tests at Kelly, interim recommendations have been made for reducing the bitumen content by 20 percent for channelized lanes for B–47 loading pending further study of other types of mixes and bitumen.

I mean that is what he actually said.

Mr. FERRY. Note what he says, sir:

Pending further tests of other types of bitumens and concentrations of asphalt.

Mr. HÉBERT. All right.

Mr. FERRY. He certainly has not said he has the answer.

Mr. HÉBERT. All right; let me ask you this categorically and positively. If and when the engineers come up and tell the Air Force that they have developed a flexible mix or a flexible paving strip to carry the 30,000 coverages——

Mr. COURTNEY. No.

Mr. HÉBERT. How is that?

Mr. COURTNEY. Carry the load for the B–52.

Mr. HÉBERT. I mean a similar test as at Kelly.

Mr. COURTNEY. Yes.

Mr. HÉBERT. Will the Air Force conduct a test similar to the one conducted at Kelly?

Mr. FERRY. Yes; and with promptness and with much pleasure to do it.

Mr. HÉBERT. All right. That is all. That is a fair answer.

Mr. MILLER. That is fair enough.

Mr. COURTNEY. Then, if I understand the testimony correctly, Mr. Ferry, your situation would be this, so far as the official position of the Air Force is concerned, and let us be clear about it: Assuming that the Corps of Engineers tell you they have reached the point of breakthrough and have achieved a design of flexible pavement which will meet the increased loads that we have talked about here—the 100,000 pounds and the 240,000 pounds—then the position of the Air Force is that at that point it would wish a demonstration test made.

Mr. FERRY. Yes, sir.

Mr. COURTNEY. And if the demonstration test proved to the satisfaction of one or both——

Mr. FERRY. Of the Air Force.

Mr. COURTNEY. Of the Air Force.

Mr. FERRY. We are the owner. We are the user.

Mr. COURTNEY. Yes. Then, on your final decision as to what you saw on the demonstration test, which I distinguish from an experimental test, you would accept the criteria that was indicated by the Corps of Engineers and incorporate it into the bidding processes of the Department of Air Force.

Mr. FERRY. Completely, sir. That is the official Air Force position.

Mr. HÉBERT. Well, that is fine. We will follow through on that, Mr. Ferry, if, and when you do it.

No. 3: "All"—and "all" is underscored:

> test traffic was applied at Kelly under high pavement temperature conditions, a situation not encountered in actual airfield pavements. As any technologist knows, this is abnormally severe for asphalt pavement and not similarly severe for rigid pavement. The severe test on rigid pavement would be loadings in extreme cold, nighttime conditions.

What comment does the Air Force have on that?

Colonel ALEXANDER. Mr. Hébert, that was partly covered in that statement I read a little bit earlier, in which I gave the temperature ranges at Kelly. I will repeat just a portion of it:

> The pavement temperatures of the asphalt pavement during the application of the traffic coverages (May and June of 1956) ranged from 67° F. to a maximum of 131° F. A substantial portion of the traffic was applied when the pavement temperatures were in excess of 90° F.

Insofar as the rigid pavement suffering more damage on cold nights than would flexible pavement, I wouldn't have any facts to bear out that statement. I think I would tend to question it, as a professional engineer. Because we do have both types of pavement in very cold climates, and one suffers no more than the other, when you talk about strictly from the cold. The cold would cause expansion and contraction of the pavement portion of the pavement structure.

Mr. BATES. Then Kelly would not have been fair.

Mr. HÉBERT. No; Kelly would not have been fair; the Kelly test.

Mr. FERRY. The Kelly test, I think, sir, was fair for airfields in the southern terrain of our country, where normal temperatures are encountered for 6 months of the year, well up into the upper 90's and above——

Mr. HÉBERT. Mr. Ferry, you weren't having the Kelly test but for overall coverage and uses.

Mr. FERRY. That is correct.

Mr. HÉBERT. So, it wouldn't be a fair test.

Mr. FERRY. It was fair in respect to the fact that we were attempting to find a criteria that could be applied for airfield uses of pavement, taxiways—we were attempting to find a criteria which could be universally applied for the purchase of flexible pavings to be used on various portions of the airfield.

Mr. BATES. Well, that is not a fair hypothesis, Mr. Ferry, is it? Any more than you design a house down South and expect it to be used everywhere, or in the North and expect it to be used everywhere.

Mr. FERRY. I think it was a fair test, Mr. Bates, in that the accelerated portion of the test would normally probably have carried into cold weather, Texas has cold weather, had it extended to the expected life of the test.

Mr. BATES. Yes, but you already exposed it to unusual temperatures for which it hadn't been designed.

Mr. FERRY. Scarcely unusual, sir. It was designed for those temperatures, because it was known to be going at Kelly Field. But it wasn't designed to that use.

Mr. BATES. But it wasn't applicable to the northern regions. In other words, the same findings would not have been determined had this been conducted at Dow Air Force Base.

Mr. FERRY. I can't agree on that, sir. I believe the same finding would have occurred.

Mr. BATES. You wouldn't have had the same element of temperature.

Mr. FERRY. The element of temperature would have varied.

Mr. BATES. And that is what we are discussing here.

Mr. FERRY. But I have no reason to believe—we are in the realm of speculation—I have no reason to believe the results would have differed had it been done at Dow or Loring, in Maine.

Mr. BATES. But, at least from the temperature point of view, from what Colonel Alexander has said, they would have started at the same level.

Mr. FERRY. That is right.

Mr. BATES. Whereas at Kelly they did not because of the asphalt being subjected to higher temperatures and the effects that it had on it.

Mr. FERRY. Except it was designed for installation in that locality.

Mr. BATES. No; it was a test for the entire Air Force.

Mr. FERRY. But it was designed—the Corps of Engineers design was based upon the fact it would be located at Kelly Air Force Base.

Mr. BATES. The design was faulty, and had the design been in the northern regions you wouldn't have the same problem.

Mr. FERRY. I do not like to use the phrase "faulty," because I don't think it was faulty. I think it was deficient; let us call it that.

Mr. BATES. We won't get into semantics, Mr. Ferry. If it doesn't work, where I come from, we say it doesn't work. We can use any language we want, but it adds up to the same thing.

Mr. HÉBERT. No. 4:

Spacing of test traffic load wheels was 20 feet instead of approximately 40 feet, as for the B–47 aircraft. This factor may have eliminated, for all prac-

tical purposes, rebound and recovery factors and induced interfacial stresses of a high order of magnitude.

Comment on that.

Colonel ALEXANDER. This is a joint comment:

It is considered that the spacing of the wheel gears did not have any significant effect on the test results.

Mr. HÉBERT. No. 5:

So-called antistrip additive was placed in the hot-asphalt mixture. This procedure is contrary to the published policy of the Asphalt Institute and could have contributed to the distress that developed.

Colonel ALEXANDER. This is a joint comment:

The amounts of antistripping agents added to asphalt are small, usually less than 1 percent by weight of asphalt, and have little or no effect on the physical characteristics of the asphalt. The fact is that this factor is not believed to have any significant effect on the test results.

Mr. HÉBERT. Now, were the Air Force aware—stepping now from Mr. Wellborn's statement to Mr. Griffith's statement of Monday, in which he testified he talked to the engineers and suggested that they be allowed to replace this distressed area at their own expense. He was told by the engineers that it was closed—it was an accompli fait, it was all over.

Was the Air Force ever in possession of any information that the representatives of asphalt or flexible paving group were willing to replace the distressed area for further test, at their own expense?

Colonel ALEXANDER. No, sir.

Mr. HÉBERT. It was never brought to their attention. Of course, it was testified by Mr. Griffith that he did not go to the Air Force. But I just wanted to clear the record up there. He assumed that it would have been negated by the Air Force, which was an assumption and not a valid observation.

Now, summarizing what has just been testified—and I will not continue after this. I want to get this clear, in black and white and in simple, understandable language, that everybody knows what we are talking about.

And I direct this to the Air Force, to Mr. Ferry.

Mr. FERRY. Yes, sir.

Mr. HÉBERT. As an official observation or acknowledgement. If the representatives of flexible pavement come to you and say, "Mr. Air Force, we now desire a test similar to Kelly——"

Mr. COURTNEY. No.

Mr. HÉBERT. Wait. I mean the type——

Mr. BATES. They want another test.

Mr. HÉBERT. Yes. In other words,

We want another test. We are not satisfied with what happened at Kelly. We believe that we didn't get a fair shake of the dice and we want another chance, and we are now prepared to offer you the product which we believe will compare favorably and be in a competitive situation with the rigid paving, will you now give us that test?

Mr. FERRY. I would give them the test, with one reservation.

Mr. HÉBERT. Getting into the reservations now.

Mr. FERRY. The reservation is I do not feel the Air Force should be put to the expense of this test wholly when it is part of a sales

campaign of the asphalt industry. I believe they should bear part of it. And I would make such an agreement with them.

Mr. HÉBERT. I think they should bear part of it. However, the Air Force did bear all the expense to prove that it wasn't good.

Mr. FERRY. That is right, sir, and now the shoe is on the other foot.

Mr. HÉBERT. Because the Air Force put it on the other foot, put the shoe on the other foot.

Mr. FERRY. Mr. Hébert, the facts put it on the other foot.

Mr. HÉBERT. Of course that is an opinion. Some of us may share it and some of us may not share it. Personally, I do not share it. We are now in a position that we know definitely that any time the asphalt people want to sell their product, you will give them the opportunity, with your reservation, which is a fair one—I grant you that.

Mr. FERRY. I will be glad to.

Mr. HÉBERT. Because we are not dealing in marbles now. We are dealing in dollars.

Mr. FERRY. Can I amplify my statement?

Mr. HÉBERT. Yes.

Mr. FERRY. I had intended this for my closing, but this seems an opportune time to state:

The Air Force is extremely anxious to find a competitive paving that will work as well as rigid paving, that can be purchased cheaper than rigid paving.

If the Asphalt Institute or the asphalt industry, or representatives of the bituminous industry can produce such a paving, the Air Force is extremely anxious to adopt and use it, to stand up under the requirements that we impose upon it.

Mr. HÉBERT. Of course, that is a very laudatory statement, except that the action of the Air Force indicates to the contrary.

Mr. FERRY. I, again, sir, respectfully take issue there.

Mr. HÉBERT. That is right. It is an opinion. The record speaks for itself. We just heard the testimony of the general, that General LeMay wants all concrete, period.

Mr. FERRY. I am now speaking in an official Air Force position.

Mr. HÉBERT. I know how you are speaking, but I want to show you what the trend is, and what the thinking is. We wouldn't be here today if objections were not received.

Mr. FERRY. True, sir; and if it was not a controversial subject it would not have occasioned so many comments.

Mr. HÉBERT. All right. On behalf of the committee, I will say—speaking for myself on the approbation—when the Air Force gets ready for the test, notify the committee and let us know, so we will have first-hand information. That is, if they want such a test. And one of the requirements or requisites that I would indicate to them would be that before the first coverage is made, No. 1 coverage, that they say, "This is our product, this is what we offer, this is what we expect to fall or rise on, on the test." So there will be no aftermath or no repercussions of what was done and what wasn't done.

In this particular case, as I understand it, the asphalt industry was not represented and only allowed observers after the fact.

Mr. FERRY. For the record, neither were the rigid paving, the portland cement concrete.

Mr. HÉBERT. The record shows that. So if the competent people want to come in and say—this is the same way as a race horse. You put the two race horses in a starting gate and they are supposed to be ready. And then no excuses afterwards. That is all I want. I just want a fair shake of the dice for everybody. I want it put in a competitive position, that the people can save some money in this thing.

Mr. FERRY. And the Air Force is in complete accord with the chairman's statement. We are completely in accord.

Mr. HÉBERT. You couldn't put it on a line better than that.

Mr. FERRY. Yes, sir.

Mr. BATES. Mr. Chairman, there was just one thought that ran across my mind which you touched on that concerned me the other day, and that was the question of consulting with the industry.

Many times in the Government we give direct contracts to the industry to develop their product for specific purposes. In this particular instance it appeared that you bypassed both the cement and the asphalt people.

I don't understand the point of view of the Engineers, I presume it is in this case, in assuming that attitude when there are people available who work with this product day in and day out, and it is their business and they are in the industry. Why don't we take advantage of whatever suggestions they might have to offer?

Mr. FERRY. Mr. Bates, I think that question should perhaps more suitably be addressed to General Wilson or his representatives than myself. Because we were not involved in the design of this, nor the arrangements.

Mr. BATES. I understand that. But if there is anybody here from the Engineers, I would like to have him comment.

Mr. HÉBERT. General Wilson is here.

Mr. FOGO. General Wilson is here.

Mr. HÉBERT. General Wilson.

General WILSON. I would prefer to have that question addressed to me when I get up on the stand, if I may, sir.

Mr. HÉBERT. All right, General.

Mr. BATES. If the general is coming, we will get to him later.

Mr. HÉBERT. Now, one final question and then I think we will be finished with you gentlemen, for the moment, anyway.

The Engineers testified, Mr. Ferry, that they had asked the Air Force to supply them $800,000 over a 4-year period to make more extensive tests on flexible pavement. Are you going to do it?

Mr. FERRY. We are not going to give them $800,000 a year for 4 years. Due to stringency of money, we thing it is an extravagant use of test money. We will give them what we believe to be an adequate sum.

Mr. HÉBERT. In other words, you are not going to give them that?

Mr. FERRY. I am not going to give them $800,000 a year for 4 years.

Mr. HÉBERT. How much are you going to give them?

Mr. FERRY. I would like to consult with my people and see the program before I gave you that answer, sir. Because the amount of money we will give them depends on the outlined program that we think will support them. I am not in a position to answer that today.

Mr. HÉBERT. Of course, if you would give them $200,000, that could be $200,000 wasted if it wasn't adequate for the test?

Mr. FERRY. It would reduce the scope of the test, sir. I am quite certain that the Engineers, if given $200,000, will use it intelligently and for a constructive purpose. It would not be wasted.

Mr. HÉBERT. But it wouldn't accomplish the objective.

Mr. FERRY. It might or might not, sir. It depends on the objectives that we decide are worthwhile fulfilling. Because, remember, the Air Force has just so much money available to it and we are not going to put ourselves in the position of acceding to any test that the Corps of Engineers may propose to make for us. We will use—we will exercise judgment in the selection of what form and type of testing they are to do.

Mr. HÉBERT. I would say that this is the first time I have heard that any department has come up here and decried the fact of a research or development might be extravagant. They usually want all the money they can get for it, because they don't know what end of the funnel they are coming out of.

Now, in this particular, isolated case we finally find the Department taking the position that they determined ahead of time that it is a waste of money.

Mr. FERRY. No, sir; I did not say that. I said we would determine, in our judgment, whether the tests were sufficient and of sufficient import to our business to warrant the money.

Mr. HÉBERT. Don't you consider the saving of dollars in competitive bidding warranted, the possibility of it?

Mr. FERRY. I certainly do, Mr. Hébert, but I have no reason to believe that that magic $800,000 for 4 years is necessarily that amount of money needed. I must exercise judgment of my own.

Mr. HÉBERT. Then you will come up with your own magic figure.

Mr. FERRY. No, sir; it will not be a magic figure. It will be the amount of money which we think we can afford to spend for research on worthwhile projects.

Mr. HÉBERT. We are getting nowhere fast, Mr. Ferry. I will just have to let the record stand where it is.

Mr. FERRY. That is right, sir. I am satisfied.

Mr. CUNNINGHAM. Mr. Chairman.

Mr. HÉBERT. Yes, Mr. Cunningham.

Mr. CUNNINGHAM. I want to thank Mr. Ferry. I think he has been very cooperative and very helpful to the committee.

Mr. FERRY. Thank you, Mr. Cunningham. I have tried to be. I would like, if I may, before the Air Force portion of it is finished, to make a valedictory statement, if you call it that.

Mr. HÉBERT. I am sure it won't be valedictory.

Mr. BATES. We hope it won't be that, Mr. Ferry.

Mr. HÉBERT. It will be a statement.

Mr. BATES. Always enjoy having you before our committee.

Mr. FERRY. Colonel Alexander is most anxious to get one statement in on the Kelly test. We have some data we would like to enter into the record which will make it still more voluminous.

Mr. HÉBERT. Enter anything you want.

Mr. FERRY. Thank you, sir. I would like to come back and make this statement, that it seems to me, sitting here and listening as a very

interested spectator, that we have had much information—valid, useful, sincere information—from all people concerned, but it has tended to become a little diffuse and spread itself into nonessentials.

I would like to bring it back to what the Air Force considers essential. So far, we in the Air Force have no conviction, no evidence, that we can use a flexible pavement to withstand the wheel loads and the frequency intended of heavy bombers on pavement of taxiways and runways.

The whole object of the Air Force is to achieve pavements, whether rigid or flexible, that will withstand this load.

We leave aside the supplementary factors of blast effect. We leave aside the visibility effect. We leave aside the spillage of fuel. All of which are of importance, but they are not the major ones.

We in the Air Force have no assurances from our construction agents that they can produce a flexible pavement to meet our requirements. Until they do so, sir, the Air Force does not feel warranted in continuing to use flexible pavements in critical areas. And I beg and request the chairman and the members of the committee to accede to this continuation of the program we have followed for the last 6 or 8 months, until such a suitable pavement, of flexible type, can be designed and proven.

Mr. HÉBERT. You have something for the record, Colonel, that you want to put in?

Colonel ALEXANDER. Yes, sir. This relates to Kelly. Throughout the testimony presented, the Asphalt Institute has repeatedly stated that this test was no test at all and it was doomed to failure before it started.

It is interesting to note, however, that in the March 1956 issue of Construction Methods it carries a statement by Mr. Wellborn commenting on the then proposed Kelly test as follows:

> We are confident that the scheduled test at Kelly will be conclusive vindication of flexible pavement for airfield runways. Without exception, Mr. Wellborn and others who criticized the Kelly test are basing this criticism on hindsight.

I have a photostat from the Construction Methods for the record with that statement, sir.

Mr. COURTNEY. We will have a problem with the picture, you know.

Colonel ALEXANDER. Yes, sir.

Mr. BATES. Let me see that page.

(The statement referred to is as follows:)

KELLY AFB

We will now consider another item about which the asphalt interests have made much ado. This concerns the test conducted at Kelly AFB, Tex. Exhibit D-2 of the exhibit material from the Asphalt Institute summarizes its analysis of this test. Throughout the testimony presented the Asphalt Institute has repeatedly stated that this test was no test at all and that it was doomed to failure before it started. It is interesting to note that the March 1956 issue of Construction Methods carries a statement by Mr. Arvin Wellborn commenting on the Kelly test as follows:

"We are confident that the scheduled tests at Kelly will be conclusive vindication of flexible pavement for airfield runways" (exhibit 1).

Colonel ALEXANDER. Without exception, Mr. Wellborn and others who criticize the Kelly test are basing this criticism on hindsight.

The pavement test performed at Kelly AFB was to demonstrate that both rigid and flexible pavement could be designed and con-

structed in the field by normal construction and inspection procedures and be capable of carrying channelized traffic. The preparation of designs, plans, specifications, and testing was under the complete control of the Corps of Engineers. The details of the number of coverages used as a basis of design, percent of asphalt used in the mix, amount of portland cement used in the concrete, and various types of base courses were all developed by the Corps of Engineers.

At this point we desire to include in the record a joint USAF-OCE comment on Mr. Wellborn's summary report.

(The USAF-OCE comment follows:)

USAF-OCE COMMENTS ON SUMMARY REPORT ON THE STATUS OF FLEXIBLE PAVEMENTS FOR HEAVY MILITARY AIRCRAFT, BY ARVIN S. WELLBORN, CHIEF ENGINEER, THE ASPHALT INSTITUTE, ENCLOSED IN LETTER FROM THE ASPHALT INSTITUTE TO THE CHIEF OF ENGINEERS, DATED FEBRUARY 11, 1957

1. *Preface, paragraph 1, statement.*—In recent weeks, elements of the engineering press armed with insufficient information have attempted to appraise the status of flexible pavements for modern military airfields. These appraisals have been based on incomplete data from a single pavement test conducted during the summer of 1956 at Kelly Air Force Base in Texas.

Comment.—None.

2. *Preface, paragraph 2—statement.*—It is the considered judgment of the Asphalt Institute after an extensive review of all the facts that the test at Kelly AFB could have ended no other way than distress in the asphalt section. A combination of factors, readily understood by asphalt technologists, doomed the pavement to failure before the first test loading was placed on it.

Comment.—The statement is not factual. The Kelly test track was designed and constructed according to the best and most highly developed design concepts available at that time.

3. *Preface, Paragraph 3, Statement.*—Further, since the suspension of testing at Kelly, new pavement test loading conditions have been established that are totally unprecedented in the history of pavement design. In fact, the new conditions have removed pavement design entirely from the realm of contemporary paving technology and placed it in a new and uncharted dimension.

Comment.—None.

4. *Preface, Paragraph 4, Statement.*—It must be borne in mind that flexible pavements today are serving fully the requirements of our heaviest bomber aircraft at many Air Force installations. Consequently, we must apply very critical judgment to the results of the Kelly test and ask: Why failure here?

Comment.—There are a number of airfields having flexible pavements on which B–47 and B–36 aircraft are operating. However, in a number of cases, these pavements are showing various degrees of distress, particularly under channelized traffic conditions. Data on performance of flexible pavements under traffic of B–52 aircraft are not sufficient to judge adequacy of present design criteria. The test loading used at Kelly AFB is not as severe as the type loading that will be encountered at future multimission Air Force bases.

5. *Preface, Paragraph 5, Statement.*—Because the accounts of the Kelly AFB test have lent themselves to gross misinterpretation, seriously injuring the reputation of all flexible pavements, this engineering examination of the situation must be offered.

Comment.—None.

6. *History, Paragraph 1, Statement.*—Some elements in the Air Force long expressed dissatisfaction with flexible pavement and, in 1954, announced they were specifying concrete paving for those "critical" areas subject to jet afterburner blast and excessive fuel spillage which might have a harmful effect on asphalt pavements. In December of 1955, the Secretary of Defense authorized the Air Force to extend the term "critical" to include all "primary use areas," including those areas not subject to this spillage and heat blast. In defense of its new policy, the Air Force claimed failures in flexible pavements wherever the channelized traffic of the new B–47 bombers was applied. Seven heavy bomber bases were cited where such failures were alleged to have occurred.

Comment.—None.

7. *History, Paragraph 2, Statement.*—Granted permission to inspect these fields, the Asphalt Institute determined that only 3 of the 7 airfields showed

distress that could not be corrected with normal maintenance procedures. In the three cases of severe distress the cause was traced to faulty design and construction. In one instance elementary drainage was largely neglected. At another base, it was learned that distressed areas had not been compacted before paving. In only one case was the distress traced directly to the asphaltic concrete surface and in this instance the pavement did not meet the design requirements. In most cases proper maintenance operations were virtually nonexistent.

NOTE.—The statement of the Asphalt Institute did not specify the bases to which they were referring. Therefore, representatives of the Office of the Chief of Engineers contacted the Asphalt Institute, March 8, 1957, and was informed that the 3 airfields out of the 7 airfields inspected which showed distress that could not be corrected by normal maintenance procedures are:

Altus Air Force Base: Distress was due to improper drainage.

Pinecastle Air Force Base: Distress was due to improper compaction of the courses underlying the asphaltic concrete pavement.

Davis-Monthan Air Force Base: Distress was due to faulty design of the asphaltic concrete paving mixture.

The four fields on which the deficiencies could have been corrected by normal maintenance procedures are Tinker, Williams, Castle, and March.

Comment.—The Corps of Engineers and USAF findings are:

(*a*) Altus Air Force Base: It is not agreed that improper drainage contributed to pavement distress.

(*b*) Pinecastle Air Force Base: It is agreed that deformation of the asphaltic concrete pavement was due to densification of the underlying courses by B–47 traffic.

(*c*) Davis-Monthan Air Force Base: It is agreed that the asphalt content of the asphaltic concrete pavement mixture was slightly high.

(*d*) At the four fields, Tinker, Williams, Castle, and March, which the Asphalt Institute state could have been corrected by normal maintenance, Williams is the only one on which this could have been done. It will be noted, however, that the Air Force did not register any complaint about Williams Air Force Base. At Tinker, Castle, and March, deficiencies were beyond the category of normal maintenance.

8. History, paragraph 3, statement.—The United States Corps of Engineers expressed their confidence that asphalt pavements are entirely capable of withstanding the channelized traffic and supported this position with data from test panels constructed at their Flexible Pavements Branch at Vicksburg, Miss. The Air Force declined to accept this as conclusive evidence and requested that a demonstration-type section be constructed under normal contract conditions. Kelly Air Force Base was selected.

Comment.—There were no test data available at the time the Kelly test was contracted which would prove that the current criteria was satisfactory for designing pavements subjected to 30,000 coverages of a 100,000-pound dual wheel gear equipped with 200-pound-per-square-inch tires. The Kelly test track disclosed that the current criteria were inadequate for designing pavements subjected to 30,000 coverages of the above-referenced gear. All previous test data were predicated on 5,000 coverages rather than the currently indicated requirement of 30,000 coverages.

9. History, paragraph 4, statement.—Existing criteria were applied to the test sections, except that the test loadings requirements were increased from 1,500 to 30,000 coverages of 100,000-pound dual wheel loads under accelerated traffic and at pavement temperatures in excess of 90° F. (It should be noted that this increase in coverages was a twentyfold increase at high temperatures for flexible pavement. At the same time the increase in coverages for the rigid section was only sixfold.)

Comment.—The comparison between the increase in coverage from 1,500 for flexible pavements and for rigid pavements to 30,000 coverages is considered to be immaterial, although the existing criteria were based on accelerated traffic tests carried to only 1,500 coverages, it is considered that the criteria were adequate for 5,000 coverages in an accelerated traffic test. There was no test requirement that the traffic should be applied when pavement temperatures were in excess of 90° F. However, asphaltic concrete pavements should perform adequately at this temperature. The pavement temperatures of the asphalt pavement during the application of the traffic coverages—May and June 1956—ranged from 67° F. to a maximum of 131° F. A substantial portion of the

traffic was applied when the pavement temperatures were in excess of 90° F.

10. History, paragraph 5, statement.—During the construction of the pavement, it became apparent to the Asphalt Institute serving as an observer that the paving mix required by Air Force mandate was clearly too rich to sustain the accelerated test traffic immediately after construction, in the mid-summer Texas heat. Any experienced asphalt technologist knows how an overrich asphalt mix will behave.

Comment.—No data existed prior to the Kelly test regarding the performance of an asphalt pavement designed in accordance with current criteria and subjected to 30,000 coverages of a 100,000-pound dual wheel gear, equipped with 200-pound-per-square-inch tires.

The paving mixtures were designed in accordance with OCE criteria at the time of construction. Asphalt pavements with asphalt contents of 3.5 percent for binder course and 5 percent for surface course cannot be detected as being "rich" based on visual observations during construction.

The single process of reducing asphalt content is one approach to producing a satisfactory pavement for channelized traffic of heavy military aircraft. Other changes in mix design are being investigated.

The Asphalt Institute observers present during the conduct of the tests at Kelly AFB made no comment regarding the adequacy of the design or construction nor is there any record of expressions to the Corps of Engineers that modification of the asphaltic concrete mix was required.

11. *History, paragraph 6, statement.*—When the institute's worst fears were realized and the pavement showed early distress, the asphalt industry proposed that the faulty test section be removed and reconstructed with a more appropriately proportioned mixture. The Air Force declared itself satisfied with the result and ordered the tests terminated—although normal procedure by experienced engineers under these circumstances would have been to modify the mix, making it leaner, and retest.

Comment.—The object of the Kelly test track was to determine whether pavements constructed in the field under normal procedures and using current criteria could be built to withstand actual operating conditions particularly channelized traffic. The section of the field used for the test track was an operational facility and could not be used for continued testing.

12. *Analysis of the test, paragraph 1, statement.*—For reasons not entirely clear, the test called for 30,000 coverages at accelerated rate of the 100,000-pound gearload at pavement temperatures not lower than 90° F., although it is apparent that those extreme conditions will never be encountered in actual airfield operations. The existing mix design criteria then in use by the Corps of Engineers called for 1,500 coverages of accelerated traffic under high pavement temperatures. Pavements designed by these criteria are today carrying heavy bomber traffic without distress.

Comment.—The 30,000 coverages is based on sixfold increase in traffic produced by channelization of B–47 aircraft. While it is recognized that the rapid rate of applications of traffic coverages in a short period of time and at the relatively high pavement temperatures experienced at Kelly AFB is admittedly severe and does not duplicate the prototype conditions, in many ways the use of 30,000 coverages is not unrealistic.

The pavement temperature during the application of the traffic ranged from 67° F. to 131° F. A substantial portion was applied at temperatures in excess of 90° F. The severe effect of hot-weather traffic was not fully recognized prior to the Kelly tests.

It is recognized that accelerated traffic tests produce traffic conditions on the pavement which are in general more severe than prototype conditions. Accelerated tests are necessary to eliminate unduly long periods of testing and to secure early results.

The statement that "the extreme condition will never be encountered in actual airfield operations" is at variance with available data. The data indicates that it is not unusual for pavement temperatures to reach 140° F. in the South and Southwest portion of the United States.

Some flexible pavements are carrying B–47 traffic satisfactorily and others are not. There are not sufficient data available to prove or disprove that flexible pavements designed in accordance with current criteria are satisfactory for traffic of B–52 aircraft. However, the asphalt pavements on the Kelly test track failed under channelized traffic (about 9,000 coverages) of a B–47 load. The statement that coverages be conducted at temperatures not lower than 90° F. is incorrect as no temperature limits were specified.

13. *Analysis of test, paragraph 2, statement.*—The decision to step up the tempo of the accelerated traffic in the hottest summer months must be recognized as an unrealistic requirement. This accelerated traffic coverage was scheduled at a rate of 500 coverages per day which is the equivalent of a full month's use of the pavement under prototype traffic. To withstand this type of testing, it is only logical that the asphalt mixture should have been designed with a proportionately leaner asphalt content. This was recognized by the Corps of Engineers. However, they were not given the opportunity to adjust the mix and retest.

Comment.—It is recognized that the rate of application of the coverages to the Kelly test pavements is much faster than is applied to a prototype pavement and the pavement temperatures during the test were more severe than prototype conditions.

The statement that "it is only logical that the asphalt mixture should have been designed with a proportionately leaner asphalt content" is a true statement based on subsequent investigation work but represents a "back sight" on the part of Mr. Wellborn, as neither the Asphalt Institute nor the Corps of Engineers realized the mix was too rich until after the traffic had been applied. Lowering the asphalt content of a mixture is only one approach to satisfactory performance of a pavement under traffic but may produce an unsatisfactory pavement for prototype traffic.

14. *Analysis of test, paragraph 3, statement.*—Let us summarize the curiously mixed factors that were jammed into the test equation:

(*a*) *Paragraph 3 (1), statement.*—The Air Force required the asphalt pavement to be designed on the basis of criteria established with 1,500 coverages of accelerated test traffic at high temperatures.

Comment.—This statement is at variance with the facts. The test pavements, both rigid and flexible, were designed in accordance with current criteria based upon the best available data for 30,000 coverages of a 100,000-pound gear (dual wheels) equipped with 200 pounds per square inch tires.

(*b*) *Paragraph 3 (2), statement.*—Test traffic applied at Kelly, however, was 30,000 coverages, or 20 times the amount on which the pavement mix design criteria were based.

Comment.—Although the mix design criteria had been based on 1,500 coverages, it was considered that the design criteria were adequate for 5,000 coverages. Past test experience indicated that when the pavement properties did not change after a reasonable number of coverages design criteria were established based on the properties of the unfailed pavements. However, at the time the current criteria were established, it was not known that B–47 aircraft would subject pavements to channelized traffic.

Subsequent studies indicate that it is reasonable to expect that a pavement may be subjected to 30,000 coverages of B–47 aircraft in the center of taxiway and on edges of aprons.

(*c*) *Paragraph 3 (3), statement.*—All test traffic was applied at Kelly under high pavement temperature conditions, a situation not encountered in actual airfield pavements. As any technologist knows, this is abnormally severe for asphalt pavement and not similarly severe for rigid pavement.

Comment.—The statement that "all traffic was applied under high pavement temperature conditions, a situation not encountered in actual airfield pavements" is only partially true as the coverages on the Kelly test track were applied when the pavement temperatures ranged from 67° to 131° F.

A great number of coverages in a prototype pavement would be applied at temperature much below 90° F. However, pavement temperatures exceeding 140° F. are encountered frequently in the southern portions of the United States. Pavement temperatures up to 160° F. have been observed at Yuma, Ariz.

(*d*) *Paragraph 3* (4) statement.—Spacing of test traffic load wheels was 20 feet instead of approximately 40 feet, as for the B–47 aircraft. This factor may have eliminated for all practical purposes rebound and recovery factors and induced interfacial stresses of a high order of magnitude.

Comment.—It is considered that the spacing of the wheel gears did not have any significant effect on the test results.

(*e*) *Paragraph 3 (5), statement.*—So-called antistrip additive was placed in the hot asphalt mixture. This procedure is contrary to the published policy of the Asphalt Institute and could contribute to the distress that developed.

Comment.—The amounts of antistripping agents added to asphalt are small, usually less than 1 percent by weight of asphalt and have little or no effect on

the physical characteristics of the asphalt. This factor is not believed to have any significant effect on the test results.

15. *Analysis of the test, paragraph 4, statement.*—In effect, the Kelly test was no test at all. This was recognized by an official of the Corps of Engineers who, at a conference of the interested parties, later declared the asphaltic concrete surface placed on the demonstration test section at Kelly Air Force Base was, in his opinion, still the best flexible airfield pavement for prototype traffic and a pavement just a little bit leaner would have carried 30,000 coverages of accelerated traffic without failure.

Comment.—The asphalt section of the Kelly test tract failed at about 9,000 coverages of channelized traffic using a 100,000 pound gear (dual wheels) equipped with 200 pounds per square inch tires.

The Corps of Engineers considers that the current criteria, which were used in the design of the Kelly pavement, are inadequate for channelized traffic. Subsequent tests conducted by Corps of Engineers where mixtures similar in character to the mixtures used on the Kelly test track but with leaner bitumen contents successfully carried 30,000 accelerated coverages of a 100,000 gear load (dual wheels).

The temperature of pavements during the traffic testing at Vicksburg, Miss., was equal to or perhaps higher than the temperature of the pavements during the Kelly test.

16. *Analysis of Test, Paragraph 5, Statement.*—In all probability the pavement built at Kelly, under any but the special and peculiar circumstances of the test, would have demonstrated a capacity to serve the requirements of our heaviest bombers without distress during the normal life expectancy of the pavement.

Comment.—This statement has no basis, in fact, inasmuch as the loadings imposed were intended to reflect operation conditions of multimission bases.

17. *Analysis of Test, Paragraph 6.*—One thing the aborted Kelly test did demonstrate: Base and subbase for flexible pavement can be built by normal contract procedures that will withstand accelerated traffic of these heavy wheel loads and perform to the complete satisfaction of the most exacting engineer. In the confused accounts of the Kelly episode, this is a fact that has been obscured.

Comment.—It was demonstrated that base course and subbase could be constructed for 9,000 coverages with no evidence of distress. This was the coverage level at the time the traffic was stopped.

18. *New Test Conditions, Paragraph 1, Statement.*—Since the Kelly test, the Asphalt Institute has learned that new test loading conditions have been established which are not only totally without precedent but far exceed the limits of present engineering knowledge. The Corps of Engineers have embarked upon a program of testing pavements under 30,000 coverages of test loads of 325,000 pounds or twin tandem gear (81,250 pounds per tire) at tire pressures of 325 pounds per square inch, and at pavement temperatures not lower than 90° F.

Comment.—While the wheel loads are unprecedented the Chief of Engineers has been informed by the United States Air Force that aircraft with gear loads of 325,000 pounds equipped with 300 pounds per square inch tires are possibilities in the future.

In view of the above, it is necessary for the Chief of Engineers to provide criteria for designing pavements adequate for the traffic of future aircraft.

19. *New Test Conditions, Paragraph 2, Statement.*—The wheel assembly test loads are approximately three times those of the B–47 bomber. They are far in excess of landing gear loads of any civil air transport, propeller or jet, existing or contemplated.

Comment.—None.

20. *New Test Conditions, Paragraph 3.*—Designing any type of pavement to meet these loads is an extrapolation into the unknown which can be established only through research. Knowledge must be gained through continued testing. Yet, testing by the Corps of Engineers has been suspended because no further funds have been allocated by the Air Force.

Comment.—The flexible pavement testing program supported by the United States Air Force is continuing at about the same rate as in the past 5 years. The Kelly test has caused the United States Air Force to curtail heavy-load testing of flexible pavements. However, funds have been made available for a limited laboratory and field program during the remainder of fiscal year 1957.

21. *New test conditions, paragraph 4, statement.*—The Asphalt Institute believes this is a problem of vital concern to the national defense and the national economy. It feels that adequate research funds should be allocated from the defense budget if we earnestly hope to preserve properly engineered construction for our Military Establishment. With $43 billion of a proposed $72 billion national budget earmarked for the Department of Defense, the lion's share of which will be expended for air defense, it seems reasonable to expect a modest appropriation for continued airfield pavement research.

Comment.—None.

22. *New test conditions, paragraphs 5 to 7 inclusive, statement.*—The institute will, of course, continue its own research in this direction. Meanwhile, however, if there is any construction method which has proved it can meet these new test conditions, the institute wishes to propose this interim solution:

The pavement distress under these increased test loads occurs exclusively in a narrow track along the center line of the runways and taxiways. Consequently, as an interim solution, it is suggested that the Corps of Engineers and the Air Force confine to the ends and center strips of its runways and taxiways whatever special construction may be required to handle this unprecedented channelized traffic. It is further suggested that the remainder of the runways and taxiways continue to be constructed of asphalt pavements because of their proven adequacy and economy.

This, we repeat, is offered as an interim construction policy in a period of accelerated transition, both in aircraft and pavement design.

Comment.—The United States Air Force has authorized the Corps of Engineers to design and construct along these lines at one Air Force base to determine whether this type construction and performance will be satisfactory.

23. *New test conditions, paragraph 8, statement.*—It is pertinent to point out that 7 of our 10 busiest civilian airports are served by asphalt pavements. Nor does Commissioner James T. Pyle of the Civil Aeronautics anticipate any need to make drastic changes in pavement design to accommodate tomorrow's jet transports. He has expressed the conviction that today's runway pavements, with some extensions where indicated, will be adequate for the transports now in design stage.

Comment.—None.

24. *The false analogy, paragraphs 1 to 5, statement.*—The Asphalt Institute is seriously disturbed by the misleading interpretation being assigned to the abortive and unrealistic pavement test at Kelly Air Force Base. The erroneous conclusions are being applied, frequently in all innocence, to highway construction.

Even if it were a valid test, which it was not, the Kelly Air Force Base test could not yield data that would apply to highway paving needs. The extreme range of tire loads rules out even the remotest relationship. The maximum legal tire load permitted on our highways lies within the 5,000-pound to 6,000-pound range. The Kelly test used a 50,000-pound tire load.

Further, highway truck tire pressures average 70 pounds per square inch; aircraft tire pressures used in the Kelly test were 200 pounds per square inch.

In the last 10 years the technology of asphalt paving has made tremendous strides. Whether a flexible pavement can be designed and built to meet the almost incredible test loadings recently introduced at Vicksburg (325,000 pounds at 325 pounds per square inch, and so forth) it is a question that only time and patient research can answer. Whether any construction can pass the test is an interesting matter for conjecture.

Comment.—Any misleading information released to the public came from sources without the sanction of either the United States Air Force or the Corps of Engineers.

Colonel ALEXANDER. There has been an abundance of testimony to the effect that the Air Force was arbitrary in shutting down the test and now allowing it to be reconstructed and retested. The fact is the test was not shut down at all but was completed by the Corps of Engineers as requested. When the flexible pavement failed the Corps of Engineers stopped the test on the flexible pavement section but continued on the rigid pavement until the prescribed number of coverages had been applied. This was the first time that rigid pavement demonstrated that it would carry this traffic without distress. In simple

terms, the test tells that the rigid pavement carried the specified loads and the flexible pavement carried less than one-third of the loads.

I, personally, was contacted by Corps of Engineers personnel with respect to reconstructing and retesting the flexible pavement part of the track. On June 14, 1956 (18,423 coverages had been completed on the rigid pavement by this date) in San Antonio, Tex., a representative of the Asphalt Institute and Mr. Horace Kerr, Zachry Construction Co., contacted me with regard to reconstructing and retesting the flexible pavement portion of the test track. At no time did anyone indicate to the Air Force a willingness to finance the reconstruction of the track at no cost to the Government. It should be noted that the testing of the flexible section was suspended by the Corps of Engineers on June 4, 1956. In view of the requirement to complete testing the rigid pavement section at the earliest possible date and to remove all testing operations from the area to allow the new runway to be placed in operation, it was necessary to proceed with further testing and design development for flexible pavement at the laboratory as originally scheduled. Kelly Air Force Base is an AMC Depot and one of its prime responsibilities is the support of the B–52's. AMC was contacted on the possibility of extension of the test but they objected to delaying occupancy of the field.

Testing was continued at the flexible pavement laboratory, using the same loading used at Kelly Air Force Base on June 29, 1956, with small test panels. It is understood that these pilot-test sections at the laboratory subsequently carried the same loads imposed at Kelly.

We would like to submit for the record the construction and repair cost for Kelly track, as furnished to us by the Corps of Engineers, as follows:

Pavement cost only

	Per square yard
2,083 square yards, rigid	$9.90
1,616 square yards, flexible	11.70

Repair cost for flexible section, approximately $900.

Additionally, we would like included in the record a detailed statement commenting on the Asphalt Institute's exhibit D–2. These comments were prepared jointly by the Office of the Chief of Engineers, and Headquarters, United States Air Force. It presents the actual facts surrounding the Kelly test.

Mr. HÉBERT. Colonel, you want to put anything else in the record?

Colonel ALEXANDER. No, sir.

Mr. FERRY. You want to get some dope in here.

Colonel ALEXANDER. Yes. I have a historical summary of the actions of the Air Force subsequent to the 1954 hearings. These are intended to accurately portray the actions of the Air Force during this period. They are also partly in rebuttal to the allegations made in the exhibit which the Asphalt Institute handed in, which we feel does not cover all of the actions of the Air Force during this period.

Mr. COURTNEY. Is this a chronological listing of Air Force actions in the period following the subcommittee agreement in August of 1954?

Colonel ALEXANDER. Yes, sir.

Mr. FERRY. And related actions.

Mr. COURTNEY. And related actions.

Mr. FERRY. Yes, sir.

Mr. COURTNEY. Mr. Chairman, may that be made a part of the colonel's testimony?

Mr. HÉBERT. Yes.

Colonel ALEXANDER. I have exhibits to go with that.

(The data are as follows:)

HISTORICAL OUTLINE

1. In order to clarify and put in one place in the record a complete historical outline of Air Force actions subsequent to the 1954 hearings, the following is respectfully submitted.

(*a*) In accordance with the conclusions contained in the 1954 report of your committee, the 5 percent premium was deleted by the Air Force in August 1954 and all pavement construction proceeded in accordance with critical and noncritical area criteria; i. e., the noncritical areas being constructed of either concrete or flexible pavement based on lowest first cost.

(*b*) In October 1954, with the approval of the Secretary of Defense, a policy was established which provides for all airfields to be constructed to heavy-load design except as follows:

(1) Where terrain or previous base development would preclude the economic expansion of one or more essential runways for utilization for medium bomber, and heavy bomber, heavy cargo, or similar type aircraft.

(2) At airfields not owned in fee by the USAF where terms of lease or base rights are inconsistent with the extended Air Force tour, or where agreements restrict operations to other than heavy aircraft.

(3) At permanently established basic-training stations.

(4) At flying fields auxiliary to main bases and gunnery bases.

(5) At fighter alert taxiways and other small or limited-use facilities provided solely for fighter-type aircraft.

This policy established the multimission concept (exhibit 1, IECM 54–29 (100.1.1), airfield pavement design).

(*c*) In early 1954 a report was received of serious distress in a flexible-pavement taxiway. Studies were undertaken and a new phenomenon was observed on airfields, which was named or called channelized traffic. The first field to give an indication of this problem was March Air Force Base. Studies were undertaken by the Corps of Engineers for the Air Force and, as a result of these studies, design criteria were changed by the Corps of Engineers to provide for an increase in thickness of the center 25 to 30 feet of taxiways in both flexible and rigid pavements.

As there was some doubt and as yet no proof as to the capability of flexible pavement to withstand this intensified utilization, a request was made to the Secretary of Defense on May 2, 1955, for the use of portland cement concrete on primary taxiways on an interim basis pending development of a flexible pavement that would adequately withstand channelized traffic (exhibit 2, memo to OSD dated May 2, 1955). The Secretary of Defense approved the use of portland cement concrete on primary taxiways on June 28, 1955, as an interim measure, and suggested an accelerated investigational program to prove the adequacy of the designs of both rigid and flexible pavement for channelized traffic (exhibit 3, memo from OSD to Secretary of the Air Force, dated June 28, 1955). Revised Air Force criteria for rigid pavement on primary taxiways were published July 22, 1955 (exhibit 4, IECM 55–54 (135.1.1), primary taxiways). In cooperation with the Corps of Engineers in early July 1955, a testing program was established to develop designs for flexible and rigid pavement for channelized traffic areas. This program, including accelerated traffic tests, was authorized by Headquarters, USAF, on July 27, 1955, and the Corps of Engineers was requested to perform them (exhibit 5, memo to OCE, July 2, 1955). These traffic tests included work at the rigid pavement laboratory, the flexible pavement laboratory and a field demonstration at Kelly Air Force Base.

(*d*) In the meantime, and subsequently, reports were being received on distress in flexible pavements not only in channelized areas, but in other parts of the airfields. In view of these circumstances, the Secretary of Defense was requested to authorize the discontinuance of flexible pavements on Air Force bases on October 28, 1955. This request was based on distress at the following

bases: March, Pinecastle, Castle, Hunter, Davis-Monthan, Altus,, Ben Guerier, Yuma, Luke, Homestead (exhibit 6, memo to OSD, October 28, 1955). The Secretary of Defense on December 20, 1955, approved the request to use portland cement concrete on all primary-use pavements (exhibit 7, memo from OSD dated December 20, 1955). Primary-use pavements are defined as follows:

(1) All paved areas on which aircraft are regularly parked, serviced, maintained, or preflight checked;

(2) All runways having adequate length, width, and approaches to permit sustained use by combat or combat support aircraft; and

(3) Taxiways connecting paved areas defined in (1) and (2) above.

On the same date, December 20, 1955, a letter from OSD was forwarded to the chairman of the Subcommittee on Defense Activities informing him of the approval of the use of rigid pavement for primary taxiways and runways (exhibit 8). Design criteria were published January 18, 1956 (exhibit 9, IECM 56-8 (100.1.1), selection of types, design, and alternate bid schedules).

(*e*) Due to the apprehension of the possible increase in distress of flexible pavements, a letter dated January 20, 1956, was sent to all major air commands announcing the new pavement criteria and calling upon the commanders to maintain the highest degree of maintenance possible to insure the maximum life of asphaltic concrete pavements now in place (exhibit 10).

(*f*) With the advent of the B–52 and indications that weights of this aircraft would increase over the initial model and would impose loads greater than the 100,000 pounds on dual wheels, the heavy load design was changed to 240,000 pounds on twin-twin gear on May 25, 1956 (exhibit 11), IECM 56–34.

We would like to note here that the above-outlined developments which have resulted in present pavement policy were not, as have been charged by the Asphalt Institute, for the purpose of circumventing the 1954 recommendations of this subcommittee, but have in fact been caused by developments which have taken place since that time.

EXHIBIT 1

DEPARTMENT OF THE AIR FORCE,
HEADQUARTERS, UNITED STATES AIR FORCE,
Washington, D. C., October 12, 1954.

AFCIE–EE/C
Air installations criteria memorandum 54–29 (100.1.1)[1]
Subject: Airfield pavement design.

Purpose: This AICM establishes and outlines criteria for the selection of design loads for airfield pavement, exclusive of shoulders, at Air Force installations. Design for shoulder pavements will be the subject of a separate AICM.

Scope: Two types of aircraft gear loading are defined and the general principles for determining the design load to be used are explained.

Definitions: Heavy load design: A load of 100,000 pounds supported on a single landing gear having dual wheels, spaced 37½ inches center to center, each vessel having a contact area of 267 square inches.

Light load design: A load of 25,000 pounds supported by a single landing gear having a single wheel and a tire pressure of 200 pounds per square inch.

Heavy load: This design will be used for all airfield pavements at all Air Force installations, except under the following conditions:

(*a*) Where terrain or previous base development would preclude the economic expansion of one or more essential runways for utilization by medium bomber, heavy bomber, heavy cargo, or similar type aircraft.

(*b*) At airfields not owned in fee by the USAF where terms of lease or base rights are inconsistent with extended Air Force tenure, or where agreements restrict operations to other than heavy aircraft.

(*c*) At permanently established basic training stations.

(*d*) At flying fields auxiliary to main bases and gunnery ranges.

(*e*) Where extensions, additions, or widenings are to be made to existing understrength pavement and no provision has been made for strengthening abutting pavement. A further exception is here made in case of apron additions: Mass apron additions of 50,000 square yards or more will be designed for heavy load criteria regardless of strength of abutting pavement; however, this rule will not apply in the case of apron access taxiways or other narrow peripheral additions to existing parking facilities.

[1] This memorandum rescinds letter, this headquarters, to Office, Chief of Engineers, dated January 3, 1951, subject, criteria for airfield pavement construction at Air Force installations.

(*f*) Fighter alert taxiways and other small or limited use facilities provided solely for fighter type aircraft.

(*g*) Access aprons to maintenance hangars, types A and B wash racks, and jet engine check pads for medium bomber or heavy bomber aircraft. The design load for these facilities will be reduced to 80,000 pounds.

Application of the heavy load design criteria pertains only to pavement strength and will not be construed as requiring additional lengths, widths, or additional paved facilities not required by the assigned mission.

Light load: This design will be used for all airfield pavement to be constructed at all other Air Force installations where it will satisfy the mission requirements. Where additions or extensions are made to existing pavements which do not meet light load criteria, but are otherwise adequate for the assigned mission, the new pavement will be designed to match the strength of the existing pavement. Where existing pavements are substandard or otherwise inadequate for the assigned mission they will be strengthened to light load criteria concurrently with the construction of the addition or extension. For type C wash racks the load will be reduced to 20,000 pounds.

Design method: Pavement design will be based on procedures set forth in part XII, chapters 2 and 3, of the Corps of Engineers Engineering Manual or the Bureau of Yards and Docks (Navy) Airfield Pavement Technical Publication NAVDOCK TP–Pw–4.

Applicability: These criteria are applicable to the fiscal year 1956 and future construction programs.

EXHIBIT 2

MAY 2, 1955.

Memorandum for Assistant Secretary of Defense (Properties and Installations)
Subject: Change in designation of critical areas for airfield pavements.

1. Recent observations and reports of pavement distress on primary taxiways at Air Force installations and investigations of the behavior of airfield pavement under concentrated channelized aircraft traffic support a requirement for revising pavement design criteria. It is therefore proposed that primary taxiways at multipurpose use Air Force installations be constructed of rigid pavement.

2. The current difficulty with pavements under concentrated channelized traffic is not confined to either rigid or flexible pavement; failures due to the repeated passage of heavy weights over the same spot have occurred in both types. For flexible type pavement, no acceptable solution has been achieved, and further studies over an extended period are necessary before a flexible pavement design specification can be developed. Skepticism has been expressed that flexible pavements can ever achieve the density necessary to support these concentrated weights during thousands of coverages. In the case of rigid pavement a solution is readily achieved by slightly increasing the pavement thickness. These failures and the studies underway to correct them are different from those previously undertaken by the National Research Council on heat, blast, and fuel spillage. The change proposed above is considered an interim measure pending final solution of the problem.

3. The proposed change will be applicable to the fiscal year 1956 and future military construction programs. It is estimated that the change will increase the cost for taxiway pavement items in the fiscal year 1956, military construction program $2 million.

4. Approval is requested pursuant to your memorandum of February 2, 1954, subject: "Changes in Criteria and Construction Standards."

JOHN M. FERRY,
Special Assistant for Installations.

EXHIBIT 3

ASSISTANT SECRETARY OF DEFENSE,
Washington, D. C., June 28, 1955.

Properties and installations
Memorandum for the Secretary of the Air Force
Subject: Change in designation of critical areas for airfield pavements.

The proposal made by Mr. Ferry in his memorandum of May 2, 1955, that primary taxiways at multipurpose-use air installations be constructed solely of rigid-type pavement is concurred in on an interim basis for the fiscal year 1956 program pending completion of texts on flexible pavements.

It is assumed that an adequate accelerated test program will be authorized without delay in order that necessary design data may be established for the use of flexible pavements under concentrated channelized aircraft traffic.

FRANKLIN G. FLOETE.

Copy furnished to Secretary of the Navy.

EXHIBIT 4

DEPARTMENT OF THE AIR FORCE,
HEADQUARTERS, UNITED STATES AIR FORCE,
Washington, D. C.

AFCIE-EE/C
Air Installation Criteria Memorandum 55-54 (135.4.1)
Subject: Pavements and grounds, airfield pavements, primary taxiways.

Purpose: The purpose of this air installations criteria memorandum is to furnish guidance in consideration of the thickened-center-section design of primary taxiways to overlay or strengthening projects at multimission installations.

Discussion: By letter, this headquarters, subject: Design of Heavy Load Airfield Pavement at Air Force Installations, April 27, 1955, the design and construction agents were requested to strengthen the center 25-foot section of primary taxiways at multimission Air Force installations by adding 20 percent to the standard design thickness. Implementing design and construction criteria have subsequently been released by the Office of the Chief of Engineers. On June 27, 1955, the Office of the Secretary of Defense authorized the Air Force to construct these taxiways solely of rigid pavement, pending development of a suitable flexible pavement design. In adapting the thickened-center-section principle for rigid pavements to overlay or strengthening projects, local conditions may be such that strict compliance with the above criteria may be impractical or uneconomical by reason of gradients of existing adjacent or abutting shoulders and pavements, existing drainage, utility, and other under pavement systems, et cetera. In some cases a combination of rigid and flexible pavement may be the most practical and economical solution.

Procedure: In cases of taxiway strengthening, where a combination of rigid and flexible pavement is indicated to be the only practical solution but results in a major deviation from criteria, comparative estimates, and justifications will be submitted by the responsible Air Force Installations representatives to this headquarters for final decision.

Implementation: These criteria are applicable to the fiscal year 1956 military construction program only. Implementation is mandatory, subject to the following:

(*a*) Time permitting, by addendum to the bidding documents prior to and without delaying the receipt of bids.

(*b*) When time does not permit, by change order.

(*c*) When a delay in contract award and completion, affecting the scheduled utilization of a facility, will result from the incorporation of a mandatory change, due, for example, to the need to reprogram additional funds, Air Force Installations representatives will advise this headquarters as to the effect of the implementation and will request decision as to further action.

EXHIBIT 5

JULY 28, 1955.

AFCIE–ES

Memorandum for Chief of Engineers, Department of the Army

Subject: Accelerated traffic test for the development of pavement design criteria for channelized traffic

1. At the request of the Air Force, a meeting was held on July 21, 1955, attended by representatives of OCE, BuDocks, and traffic tests for development of pavement design criteria for channelized traffic.

2. The proposals submitted by the ORDL and Vicksburg Laboratories have been reviewed and it is deemed desirable to perform both the tests for development of pavement design and for proof-testing the present modified design for channelized traffic.

3. Fiscal year 1956 military construction program funds in the amount of $516,000 will be allotted to you as soon as they become available. This amount includes $234,000 for flexible pavement design study, $232,000 for rigid pavement design study, and $150,000 for proof testing the present modified design at a location to be jointly agreed upon by your office and this headquarters. The hundred thousand dollars has been subtracted from the total of $616,000 as representing a portion of the presently projected investigational program for fiscal year 1956 that the laboratories would not have the capability of executing simultaneously with the design studies and proof testing. The projected investigational program should be further examined for elimination of any projects duplicated or made unnecessary by the above studies.

4. It is requested that the studies and tests be expedited to the maximum extent in order the criteria developed may be integrated in the military construction program as soon as possible.

For the Chief of Staff:

WILLIAM E. LEONHARD,
Colonel, United States Air Force, Acting Director of Construction,
Assistant Chief of Staff, Installations.

EXHIBIT 6

OCTOBER 28, 1955.

MEMORANDUM FOR ASSISTANT SECRETARY OF DEFENSE (PROPERTIES AND INSTALLATIONS)

Subject: Selection of airfield pavement types for Air Force construction

1. Continuing failures and unsatisfactory performance of bituminous airfield pavements designed and constructed for modern jet aircraft make it imperative to request your assistance in terminating this type of construction.

2. Concurrently with our request of May 2, 1955, for the specific use of portland cement concrete for primary taxiways, which was approved by your office June 28, 1955, performance of bituminous runways were being closely observed. These observations revealed that major deficiencies developed within a relatively short period following operational use. They included rutting, subsidence, bleeding, surface movement under traffic, temperature cracking and slipperiness when wet. Greater importance however is attached to the effect on aircraft operations such as damage to instruments, structural damage, both of which have caused aborted missions; aircraft control during takeoff or landing; excessive aircraft maintenance; and loss of combat effectiveness. Examples of the deficiencies are cited in the attached enclosures, 1 through 10. The costs shown reflect correction of surface deficiencies only. Costs for correcting the basic structural deficiencies require a thorough engineering field investigation. Our design and construction agent has been requested to proceed with such an investigation and to provide estimated costs to bring the pavements up to an acceptable operational minimum. The preponderance of evidence clearly indicates that the theoretical designs for bituminous pavements developed by our design and construction agents have not or cannot be achieved in actual practice.

3. Continuing large expenditures for construction of runways and taxiways which fail to provide satisfactory minimum operational requirements and which require excessive maintenance from the time of initial use prompts this request

to discontinue use of bituminous-type construction, except for appurtenant construction such as shoulders, runway overruns, and erosion-control areas.

4. Early approval is requested in order that appropriate revisions may be incorporated in the fiscal year 1957 MCP project planning reports scheduled for completion November 15, 1955.

Subject: Selection of Airfield Pavement Types for Air Force Construction.

GEORGE S. ROBINSON.

Ten enclosures:

1. March Air Force Base.
2. Pinecastle Air Force Base.
3. Castle Air Force Base.
4. Hunter Air Force Base.
5. Davis-Monthan Air Force Base.
6. Altus Air Force Base.
7. Ben Guerir Air Force Base.
8. Yuma County Airport.
9. Luke Air Force Base.
10. Homestead Air Force Base.

MARCH AIR FORCE BASE, CALIF.

1. There are 2 runways at March Air Force Base with only 1 runway suitable for MB or heavy-cargo aircraft. This runway (northwest-southeast) is 200 feet wide by 10,000 feet long, and constructed of asphaltic concrete throughout. It was placed in operation in May 1952. The basic trouble is in the longitudinal and transverse gradients having a series of rolls or waves. The waves vary from 100 feet to 200 feet, crest to crest; occur in a series of 4 to 6 crests and deviate from a straight-line grade as much as 0.4 foot.

The condition occurs through the entire runway with exception of a few areas up to 1,000 feet long. The condition is due partially to differential settlement; however, a study of detail data (elevations taken to 0.01 on 10-foot centers) shows that the wave condition may have been built into the pavement.

2. The wave condition causes B–47 aircraft to "porpoise" or gallop during the latter part of a takeoff run, or the first part of a landing run. Control of the aircraft is aggravated, calibration of instruments is seriously affected, and wing deflection is severe. The effect on instrumentation has been severe enough to cause aborted missions.

3. Maintenance of the runway to date consisted of planing off the high spots, and filling the low spots on the southeast 5,200 feet of the runway. This operation was completed June 27, 1955, at a cost of $72,000. The runway was closed for a period of 26 days causing the transfer of MB wing and supporting elements to another base.

4. In a 12-month period, ending September 1, 1955, there were a total of 38,586 landings and takeoffs of MB aircraft. In August 1955, there were 5,291 landings and takeoffs of MB aircraft.

PINECASTLE AIR FORCE BASE, ORLANDO, FLA.

1. The flexible portion of the easterly north-south runway (10,200 by 200 feet) has numerous surface variations. Work was completed in October 1953, at which time MB operations started. Traffic for the past 4 months was as follows: MB, 2,425; HB, 131; HC, 246; all others, 1,100.

2. Transverse settlement exists at station 86 plus 23 (location of underground drain lines) and general rutting exists, transversely and longitudinally. Rutting along the centerline is approximately 60 inches wide and tapers from 0 to 1 inch deep at midpoint. Defects are attributed to a combination of design and construction deficiencies, aggravated by the characteristics of the B–47 type landing gear.

3. Porpoising of MB aircraft is induced when landing from the south end of the runway. Birdbaths due to the depressions along the centerline of runway have an adverse effect on braking action of MB aircraft and tend to slow the aircraft down considerably on takeoffs. Aircraft commanders report that the unevenness of the surface causes the aircraft to skip and bounce thereby affecting braking action.

4. Taking into account the present flying load, consisting of a two MB-wing operation, extensive repairs will be required on or before June 1956. During the repair of the easterly north-south runway the base will be forced to conduct

limited flying operations on the parallel north-south runway. The parallel runway is of insufficient strength to accommodate fully loaded B–47 aircraft.

5. Maintenance cost to date of the easterly north-south runway has been nominal. However, present indications are that the major rehabilitation will be required in the immediate future at an approximate cost of $250,000. The existing condition of the runway is depicted by the attached photograph.

CASTLE AIR FORCE BASE, CALIF.

1. There is one runway, northwest-southeast, with normal flying operations from southeast to northwest. All distances given below are from the southeast end of the runway. The runway is 300 feet by 11,800 feet, with 1,200 feet of portland cement concrete, 8,300 feet of asphaltic concrete (strengthened in 1954), 800 feet of asphaltic concrete (new runway extension 1955), and 1,000 feet of portland cement concrete (1955).

2. Approximately 5,600 feet from the southeast end of the runway and extending northwest for approximately 1,200 feet there are a series of depressions in the runway pavement. The depressions are from 0.2 feet to 0.3 feet below normal grade line, are from 50 to 150 feet long and from 100 to 300 feet apart. (See attached profiles.)

This section of the runway was strengthened by adding an asphaltic concrete overlay on an existing asphaltic concrete pavement. The strengthening project was completed in the latter part of 1954, and flight operations involving MB and heavy cargo aircraft began immediately upon completion of the strengthening project. Currently, HB, MB, and heavy cargo aircraft use the runway. The problem is essentially one of operating HB and heavy cargo aircraft at high speeds (up to 136 knots) on a rough surfaced runway.

3. The depressions in the runway surface have the following effects:

(*a*) The depressions occur near the midpoint on the runway where landing, takeoff, or touch-and-go operations require relatively high speeds, in the case of HB's approximately 130 knots. The HB aircraft are thrown into the air and a series of two or three severe jolts occur.

(*b*) The jolts are severe enough to throw personnel, who may be riding as observers, and throw shock mounted equipment (K systems) through the entire range of the shock mountings. The "G-meter" in the aircraft registers from minus 2 to plus 2½ during the jolting.

(*c*) Wing mounted equipment, such as fuel lines, pumps, and so forth, are developing more maintennace trouble than similar equipment mounted in the fuselage. A representative of Boeing Aircraft Co. at Castle AFB stated that the extreme flexing of the wings of HB aircraft during the time the aircraft was "jolted" was at least a major contributing cause of the excessive maintenance necessary on wing mounted equipment.

(*d*) On Friday, September 23, 1955, the deputy base commander verbally advised the representatives of Headquarters 15th Air Force, that the condition of the runway was such that an operational hazard exists, and the condition should be relieved as soon as possible.

(*e*) It was the consensus of all HB pilots that control of the aircraft would be greatly aggravated when a crosswind occurs.

(*f*) Continued operation of aircraft will tend to deepen the depressions, and repeated jolting shocks will cause local failures in the runway. The major effect is on the aircraft itself in that wing mounted components require excessive maintenance; the fatigue failure of wing metals is accelerated due to the excessive flexing occurring during the jolting periods; and instrumentation K systems are thrown out of adjustment.

(*g*) Headquarters SAC has advised Headquarters USAF that the runway roughness will be a contributing factor to any accident to B–52 aircraft.

5. The pavement maintenance to date has been negligible. However, the condition of the runway is considered an operational hazard by the base commander and therefore repairs must be made as soon as possible. Preliminary estimates of the cost of repairs is $75,000 with a shutdown of the runway for a period of 2 weeks.

6. HB aircraft weighing an average of 350,000 pounds make 225 landings and 225 takeoffs (estimated) per week. This traffic is being accelerated week by week as the base continues to receive additional equipment.

2 inclosures: 1. Profile of runway station 25 plus 00 (drawing); 2. Profile of runway station 64 plus 00 (drawing).

HUNTER AIR FORCE BASE, SAVANNAH, GA.

1. The flexible portion of the east-west runway (10,500 by 200 feet) is wavy between stations 22, to 28, 56 to 65, 66 to 76, and 85 to 92, measured from the east end. Waves occur at a center to center distance of approximately 50 feet along the centerline. Work was completed in May 1952. Traffic for the period December 1953 to March 1955 was: MB, 9,352; HB, 28, H tanker, 3,108; heavy cargo, 56. Waves are deemed to be a construction deficiency, aggravated by the characteristics of the B–47 landing gear.

2. Waves cause porpoising of aircraft when taking off. Difficulty occurs between stations 56 and 65 at speeds of 90 to 100 knots.

3. Although the difficulty is not of a very serious nature at the present time, it can be expected to increase in magnitude with continued use of the runway by medium and heavy aircraft. In order to correct the defect, it would be necessary to suspend tactical operations for the period required to overlay the pavement. Two to three weeks would be required to make the repair. In the event that the defect develops to the point that complete overlayment of the 10,500 feet by 200 feet flexible portion is required the cost of repair would approximate $365,000. The attached profile depicts the existing defects.

(1 incl.—Profile Rwy.—Sta. 55 plus 00 (dg).)

DAVIS-MONTHAN AIR FORCE BASE, ARIZ

1. The primary northwest-southeast runway is 200 feet by 11,500 feet and was placed in operation in January 1953. The entire runway is asphaltic concrete except for the northwest 300 feet of portland cement concrete. The first 2,000 feet of asphaltic concrete on each end has slight rutting, and bleeding. Heavy bombers and heavy cargo aircraft leave distinct tire tread casts in the pavement. There is a slight hump 3,500 feet from the northwest end of the runway which causes B–47 aircraft to porpoise.

2. Excessive asphalt makes the runway surface soft thus requiring additional power to operate the aircraft. The kneading action of the surface obliterates the runway marking resulting in constant continuing replacement of the marking at excessive cost. The hump causes porpoising of aircraft.

3. From March 1954 through August 1955 there were 93,993 landings and takeoffs, by medium bombers and heavy cargo aircraft.

ALTUS AIR FORCE BASE, OKLA.

1. The north-south runway (17–35) was constructed under the fiscal year 52 MCP. Length is 10,800 feet; width 200 feet; flexible construction. Construction started November 26, 1952; completed March 2, 1954. Heavy tankers began flying operations April 1, 1954. There have been approximately 22,000 takeoffs and 22,000 landings. Medium bombers (B–47) began flying operations May 1, 1955, with approximately 15,000 takeoffs and 15,000 landings up to present time.

2. The following deficiencies are reported:

(*a*) There is a depression across the north-south runway approximately 1,500 feet from the south end and two small abrupt depressions across the north-south runway approximately 700 and 900 feet, respectively, from the north end of the runway. In addition, the intersection of the north-south runway with the old east-west runway is uneven for a distance of 50 feet from the outside edges of the north-south runway. To date these irregularities of the runway have not caused serious operational problems. However, since approximately 90 percent of the takeoffs are from north to south, the depressions at the north end of the runway cause B–47 aircraft to porpoise. The aircraft at the point of these depressions are moving rather slowly, and since each aircraft accelerates at the same rate, the depressions causing porposing are resulting inharmonics undesirable for takeoff in the B–47 aircraft. The B–47 type aircraft continue to porpoise until they are completely airborne.

(*b*) Observation of the north-south runway indicates that the depression at the south end of the runway and the two at the north end of the runway have developed as a result of utilization by KC–97 and B–47 type aircraft. This observation is predicated on a survey conducted by the base AIO during February 1955 when elevations of the centerline and 25 feet each side the centerline were taken. During this survey it was apparent that the runway was well within the tolerances of levelness as outlined in the specifications for the surface of this runway.

(*c*) The depression at the south end of the runway appears to be static. Observation during the past 4 months reveals that it is essentially the same to date as it was 3 or 4 months ago. This is primarily attributed to the fact that aircraft are taking off from the north to the south. The two depressions at the north end of the runway have developed within the past 90 to 120 days. Observations of these two depressions indicate that they are steadily becoming worse since they are aggravated by continued use of B–47 aircraft, and the porpoising effect the depressions cause the aircraft to undergo, which in turn affects the depressions now existent in the runway. The uneveness of the north-south runway at a point approximately 1,500 feet from the south end and the 2 small depressions across the north-south runway approximately 700 feet and 900 feet from the north end of the north-south runway has not yet caused any serious operational problems. However, the depressions at the north end of the runway seem to be progressive.

3. No maintenance has been done to date. It is proposed however to remedy the distortion at the intersection of the north-south runway and the old east-west runway under the existing paving contract.

BEN GUERIR AIR FORCE BASE, FRENCH MOROCCO

1. Approximately 1,000 feet of the primary runway has become rough. This section lies between station 20+25 and station 30+00. The rough surface causes severe pitching and lurching of B–47 aircraft upsetting the K system which controls armament, bomb sights and navigation.

2. The condition has developed since rotational operations began in January 1955. One wing operated 45 days and returned again in May 1955 and remained until the middle of August 1955. During that time there were approximately 3,000 cycles (landings and takeoffs) by MB aircraft.

3. No maintenance has been accomplished to date. Temporary repairs (leveling) will have to be accomplished in the near future as the condition worsens.

YUMA COUNTY AIRPORT, ARIZ.

1. The northeast-southwest runway is 150 feet by 9,000 feet with 8,030 feet of asphaltic concrete and 960 feet of portland cement concrete pavement (southwest end). Excessive bleeding of asphalt on the pavement exists in the 2,000 feet of asphaltic concrete on which construction was completed in June 1954, and is adjacent to the portland cement concrete section on the southwest end of the runway. The total surface affected is 3,500 square yards which is distributed throughout the southwest 2,000 feet of asphaltic concrete.

2. The bleeding condition has been alleviated by:

(*a*) Completion of the 960 feet extension of portland concrete cement thus moving all starting traffic off of the asphaltic concrete.

(*b*) Three applications of a dry aggregate blotter coat have been required. The first in August 1954; the second in December 1954 and the third in August 1955. During the period the 200 feet was used for takeoff, it was necessary to accomplish all pretakeoff engine and other checks prior to entering the runway. A skidding condition, due to the free asphalt, existed on the runway; one jet fighter aircraft skidded off the runway from a standing position after the afterburner was turned on. See attached photographs.

3. Operation of jet aircraft with high pressure tires will continue to accelerate the bleeding, which can be relieved by adding blotter courses from time to time. The major hazard is to aircraft tending to skid.

4. Traffic to date is as follows:

June 1954 to August 1955: 72,100 landings and takeoffs of jet fighter type aircraft.

June 1954 to August 1: 5,100 landings and takeoffs of heavy cargo, and MB type aircraft.

LUKE AIR FORCE BASE, ARIZ.

1. Condition: The basic condition at Luke is a bleeding of the asphaltic concrete pavement on the outboard northeast-southwest runway (3L–21R) which was placed in operation July 6, 1954. There is a 1,000 by 150 foot section of portland cement concrete, then 8,000 feet of asphaltic concrete, and a 1,000-foot section of portland cement concrete. The normal traffic is from the northeast to the southwest. Bleeding of asphalt has occurred in the northeast 500 feet of asphaltic concrete.

2. Effect on operations: None reported, as the installations engineer has been blotting and rolling as soon as the area affected is reported. No maintenance cost data available.

3. Effect on runway: Continued bleeding will result from the combination of high-pressure tires and high summer temperatures. To date, the obliteration of the runway markings is accelerated by the bleeding action.

4. Traffic data: In August 1955, there were 15,126 landings and takeoffs at Luke Air Force Base; 92 percent were fighter-type aircraft.

HOMESTEAD AIR FORCE BASE, FLA.

1. All airfield pavement under construction is of flexible pavement. Observations made during construction have caused speculation that inadequacies may appear when subjected to aircraft operations.

2. Observation of the coral base at several locations indicated a saturated condition. In other locations strata of marl (local soil) were noted. The type of rolling equipment, although adequate in numbers, did not include a roller providing sufficient footprint pressure to fully prove stability of the pavement structure.

EXHIBIT 7

ASSISTANT SECRETARY OF DEFENSE,
Washington, D. C., December 20, 1955.

Properties and Installations,
Memorandum for the Secretary of the Air Force.
Subject: Selection of airfield pavement types for Air Force construction.

Reference is made to your memorandum dated October 28, 1955, requesting that discontinuance of use of bituminous airfield pavements, except for appurtenant construction, such as shoulders, runway overruns, and erosion-control areas, be approved.

Primary runways and primary taxiways for sustained and full-capacity operation of principal combat aircraft or principal combat-support aircraft may be considered to be critical operational areas.

Rigid-type airfield pavement may be provided in critical operational areas when necessary for required sustained and full-capacity operation of principal combat or combat-support aircraft.

When provision of only one kind of airfield pavement is to be considered, the kind of pavement is to be clearly identified, and the identification is to be included and used as a part of the name or description of each item affected. This identification is to be continued through all phases of programing, authorization, funding, construction, and reporting of each facility.

For all other airfield pavements, except as otherwise finally approved by this office, the provision of either flexible-type or rigid-type pavement will continue to be made on an economic basis by direct comparison of first costs.

FRANKLIN G. FLOETE.

EXHIBIT 8

ASSISTANT SECRETARY OF DEFENSE,
Washington, D. C., December 20, 1955.

Properties and Installations

Hon. F. EDWARD HÉBERT,
Chairman, Subcommittee on Special Investigations,
Committee on Armed Services, House of Representatives.

DEAR MR. CHAIRMAN: Reference is made to the report of the Subcommittee on Defense Activities of the Committee on Armed Services, House of Representatives, 83d Congress, 2d session, on airstrip paving materials, released under date of May 30, 1954, and to my letter on this subject dated June 7, 1954.

A special committee of the Highway Research Board in the National Research Council, National Academy of Sciences, has completed a study and reported to me on the effects of military aircraft on airfield pavements. One of the recommendations of the special committee concerning the selection of pavement type is that the cost of construction and maintenance should not determine the selection of pavement type in critical areas, since the differences in costs of the

two principal types are not so great that they should take precedence over operational requirements. In noncritical areas, where either portland cement or asphaltic concrete is satisfactory, costs of construction and maintenance should be considered, along with operational requirements, in a carefully conducted engineering analysis for the selection of pavement type.

In another report covering an exhaustive study for this office by an architect-engineer, it was concluded that presently available paving methods, other than portland cement concrete, do not possess the necessary qualities of stability and endurance under heavy concentrated loadings, high air temperatures, and jet-engine blast and fuel spillage.

Analyses of these reports and reviews of other reports of airfield pavement failures and resultant interference with operational and training programs have been made by my technical staff. These indicate that portland cement concrete is the best material currently available of which hard, durable pavements with a smooth surface and nearly uniform gradients can be designed and constructed with reasonable assurance that they can be maintained to meet satisfactorily the requirements of the immediate future for the efficient, sustained, and full-capacity operation of modern, high-density, high-speed, military aircraft.

Enclosed for your information is a copy of my letter to the Air Force designating primary runways and primary taxiways for the operation of principal combat or combat-support aircraft as critical operational areas and authorizing the use of rigid-type pavement in such areas when necessary for sustained operations.

These newly designated critical operational areas are in addition to (1) all apron areas, including access ramps to hangars or docks, (2) stub parking (hardstands), (3) wash racks, (4) calibration platforms, (5) warmup pads, (6) runway ends (1,000 feet), which have been previously designated as critical by the Air Force and so presented to the Subcommittee on Defense Activities of the Committee on Armed Services by the Air Force witnesses in the airstrip paving materials hearings on February 3, 4, 5, and 6, 1954.

Sincerely yours,

FRANKLIN G. FLOETE.

EXHIBIT 9

DEPARTMENT OF THE AIR FORCE

HEADQUARTERS UNITED STATES AIR FORCE

Washington, D. C.

AFCIE-E/EC

INSTALLATIONS ENGINEERING CRITERIA MEMORANDUM

JANUARY 18, 1956.

Number 56-8 (100.1.1).
Subject: Pavement and Grounds.

AIRFIELD PAVEMENTS—SELECTION OF TYPES, DESIGN, AND ALTERNATE BID SCHEDULES

Purpose

Changing requirements and other factors have necessitated release of numerous criteria letters and memoranda pertaining to the design of airfield pavements, the selection of airfield pavement types and to related procedures for soliciting bids. It is the purpose of this Installations Engineering Criteria Memorandum to revise and consolidate these miscellaneous instructions.

The following criteria letters and memoranda are rescinded:

(*a*) Letter this headquarters dated January 8, 1954, subject: Airfield Pavement Criteria and Alternate Bid Schedules for Air Force Installations (Uncl) and amending letter, same subject, dated August 16, 1954.

(*b*) AICM 54-29 (100.1.1), dated October 12, 1954, subject: Airfield Pavement Design.

(*c*) Letter this headquarters, dated April 27, 1955, to Chief of Engineers and Chief, Bureau of Yards and Docks, subject: Design of Heavy Load Airfield Pavement at Air Force Installations.

(*d*) Letter this headquarters dated May 19, 1955, subject: Use of Tar Rubber Pavement in Critical Areas at Air Force Installations.

(*e*) Memorandum this headquarters for Chief of Engineers, dated July 8, 1954, subject: Design of Primary Taxiways at Multipurpose Use AF Installations.

(*f*) Memorandum No. 2 this headquarters for Chief, Bureau of Yards and Docks, dated July 8, 1954, subject as (*e*) above.

Criteria

(*a*) Selection of pavement types:

(1) "Primary use pavement" at all Air Force installations, will normally be constructed of portland cement concrete.

(2) The term "primary use pavement" is defined as (1) all paved areas on which aircraft are regularly parked, serviced, maintained or preflight checked; (2) all runways having adequate length, width and approaches to permit sustained use by combat or combat support aircraft, and (3) taxiways connecting paved areas defined in (1) and (2) above.

(3) Other airfield pavement will be constructed of either portland cement concrete or an acceptable type of bituminous pavement, choice being predicated on low first cost.

(4) It is recognized that conditions will arise when construction with portland cement concrete may not be practical or economically feasible. Exceptions will be considered on request to Headquarters, USAF, attention: AFCIE–E.

(5) All future actions on the part of the Air Force relating to programing authorization, funding, construction, and reporting will clearly identify that the specific use of portland cement concrete pavement is intended where such is the case.

(*b*) Design of airfield pavements: Airfield pavement will be designed for heavy load or light load conditions as follows:

(1) Definition:

(a) Heavy load: A load of 100,000 pounds supported on a single landing gear having dual wheels spaced 37½ inches center to center, each wheel having a tire contact area of approximately 267 square inches. For channelized traffic areas see criteria under design procedure.

(b) Light load: A load of 25,000 pounds supported on a single landing gear having a single wheel having a tire contact area of approximately 100 square inches.

(2) Design selection:

(a) Heavy load design: To provide flexibility for changing missions, heavy-load design will be used for all airfield pavements at all Air Force installations except under the following conditions:

1. Where terrain or previous base development would preclude the expansion of one or more essential runways for utilization by medium bomber, heavy bomber, or heavy cargo aircraft.

2. At airfields not owned in fee by the USAF where terms of lease or base rights are inconsistent with extended Air Force tenure, or where agreements restrict operations to other than heavy aircraft.

3. At permanently established basic training stations.

4. At flying fields auxiliary to main bases and gunnery ranges.

5. Where extensions, additions, or widenings are to be made to existing understrength pavement and no provision has been made for strengthening abutting pavement. A further exception is here made in case of apron additions: Mass apron additions of 50,000 square yards or more will be designed for heavy load criteria regardless of strength of abutting pavement; however, this rule will not apply in the case of apron access taxiways or other narrow peripheral additions to existing parking facilities.

6. Fighter alert taxiways and other small or limited use facilities provided solely for fighter type aircraft.

7. Access aprons to maintenance hangars, types A and B washracks and jet engine check pads for medium bomber and heavy bomber aircraft. The design load for these facilities will be reduced to 80,000 pounds.

Application of the heavy load design criteria pertains only to pavement strength and will not be construed as requiring additional lengths, widths, or additional paved facilities not required by the assigned mission.

(b) Light load design: This design will be used for all airfield pavement to be constructed at all other Air Force installations where it will

satisfy the mission requirements. Where additions or extensions are made to existing pavements which do not meet light load criteria, but are otherwise adequate for the assigned mission, the new pavement will be designed to match the strength of the existing pavement. Where existing pavements are substandard or otherwise inadequate for the assigned mission they will be strengthened to light load criteria concurrently with the construction of the addition or extension. For type C washracks the load will be reduced to 20,000 pounds.

(3) Design procedure:

(a) Pavement design will be based on procedures set forth in part XII, chapters 2 and 3 of the Corps of Engineers Engineering Manual or the Bureau of Yards and Docks (Navy) Airfield Pavement Technical Publication, NAVDOCK TO–Pw–4.

(b) Because of traffic channelizing effects of bicycle gear type aircraft (B–47 and B–52) on taxiways and runway thresholds at multimission installations, the design thickness of the center 25 feet transverse width of heavy load taxiways and the end 500 feet of runways designed for heavy loading will be increased in thickness by 20 percent.

(*c*) Alternate bid schedules: On paving projects where other than portland cement concrete pavement must be considered, the contracting officer will evaluate control estimates for the total project. If, in his opinion, the use of all rigid pavement would not increase the project cost by more than 15 percent, alternate bid schedules will be offered. Otherwise, the project will be offered for bid with the flexible pavement items and the rigid pavement items clearly delineated.

Appurtenant construction

This installations engineering criteria memorandum pertains only to pavement constructed specifically for the ground movement of aircraft. Criteria pertinent to stabilized shoulders, stabilized runway overruns, and blast erosion control features are contained in previously issued memoranda.

Implementation (mandatory)

The above mandatory criteria will be integrated into current and future construction programs, subject to the following:

(*a*) Time permitting, by addendum to the bidding documents prior to and without delaying the receipt of bids.

(*b*) When time does not permit, by change order.

(*c*) When a delay in contract award and completion, affecting the scheduled utilization of a facility, will result from the incorporation of a mandatory change, due, for example, to the need to reprogram additional funds, the Air Force installations representative will submit the problem to this headquarters.

EXHIBIT 10

DEPARTMENT OF THE AIR FORCE,
HEADQUARTERS, UNITED STATES AIR FORCE,
Washington, D. C., January 20, 1956.

AFCIE–EE.
Subject: Revised criteria for airfield pavements.
To: All major commands.

1. On December 20, 1955, the Office, Secretary of Defense, aproved an Air Force request to expand the use of portland cement concrete to include runways and primary taxiways at Air Force installations, copy attached (enclosure 1). Revised criteria incorporating this change are now being published and distributed to the field. Data submitted by your headquarters, and other independent studies, were used as a basis of the Air Force proposal.

2. With this announcement it is desired to add a word of caution. These revised criteria are not to be interpreted, and are not to be used, as a justification to replace serviceable asphaltic concrete pavements. It is, therefore, incumbent upon commanders to continue the highest practicable degree of maintenance to insure maximum usable life from asphaltic pavements now in place.

By order of the Chief of Staff.

LEE B. WASHBOURNE,
Major General, USAF,
Assistant Chief of Staff, Installations.

EXHIBIT 11

DEPARTMENT OF THE AIR FORCE

HEADQUARTERS, UNITED STATES AIR FORCE

Washington, D. C.

AFCIE–E/E

INSTALLATIONS ENGINEERING CRITERIA MEMORANDUM

(This IECM rescinds AICM 55–54 (135.4.1), July 22, 1955, and IECM 56–8 (100.1.1), January 18, 1956.)

MAY 25, 1956.

No. 56–34 (100.1.2).
Subject: Pavement and grounds.

AIRFIELD PAVMENTS—SECTION OF TYPES—DESIGN AND ALTERNATE BID SCHEDULES

Purpose

Studies recently completed on improved-performance aircraft require revisions in the design of airfield pavement. This IECM establishes a new basis of design for heavy-load pavement facilities. Previously established design for light-load pavement remains unchanged, but is restated herein for convenience.

Criteria

1. Selection of pavement types:

(*a*) "Primary use pavement" at all Air Force installations will normally be constructed of portland cement concrete.

(*b*) The term "primary use pavement" is defined as (1) all paved areas on which aircraft are regularly parked, serviced, maintained, or preflight checked; (2) all runways having adequate length, width, and approaches to permit sustained use by combat or combat-support aircraft; and (3) taxiways connecting paved areas defined in (1) and (2) above.

(c) Other airfield pavement will be constructed of either portland cement concrete or an acceptable type of bituminous pavement, choice being predicated on low first cost.

(*d*) It is recognized that conditions will arise when construction with portland cement concrete may not be practical or economically feasible. Exceptions will be considered on request to Headquarters, USAF, attention AFCIE–E.

(*e*) All future actions on the part of the Air Force relating to programing authorization, funding, construction, and reporting will clearly identify that the specific use of portland cement concrete pavement is intended where such is the case.

2. Basis of design: Airfield pavement will be designed for either heavy-load or light-load conditions.

(*a*) Heavy load: This design will be based on a gross aircraft load of 456,000 pounds supported on 2 sets of "twin-twin" gear, each gear having a wheel spacing of 36"–62"–37", the tire on each wheel having a contact area of 267 square inches. The load distribution on the fore and aft gears is calculated on the basis of 48 and 52 percent, respectively.

(1) Facility design:

(a) Hangar-access aprons, hangar floors, and types A and B wash racks will be designed for partly empty, unarmed aircraft, weighing 300,000 pounds distributed 48 percent on fore and 52 percent on rear gear.

(b) Runways, taxiways, warmup pads, parking aprons, maintenance aprons, heavy aircraft alert aprons, and similar-use areas (other than (1) (a) above) will be designed for an aircraft weight of 456,000 pounds. In developing designs for aprons, 94 percent of the aircraft traffic will be assumed to weigh 400,000 pounds or less.

(c) The center third of the transverse width of primary taxiways, and the center 100-foot transverse width of the end 500 feet of runways and the connecting area will be designed for channelized traffic.

(2) Design emphasis: All concerned, including architect-engineer firms retained for design, will emphasize that the major objective of this revised criteria is to resolve the problem of channelized traffic.

(3) Coordination of special designs:

(a) Air Force design directives will identify pavements to be specially built for purposes not satisfied by the multimission criteria above.

(b) Predesign conferences will insure proper justification of increased cost estimates for such special designs.

(c) Though no intermediate standard is established, special-purpose bases may be assigned design loads less than specified in paragraph 2 (*a*) (1) above or 2 (*b*), which follows:

(*b*) Light load: A load of 25,000 pounds supported on a single landing gear having a single wheel having a tire-contact area of approximately 100 square inches.

3. Design selection:

(*a*) Heavy-load design: To provide flexibility for changing missions, heavy-load design will be used for all airfield pavements at all Air Force installations except under the following conditions:

(1) Where terrain or previous base development would preclude the expansion of one or more essential runways for utilization by medium bomber, heavy bomber, or heavy-cargo aircraft.

(2) At airfields not owned in fee by the USAF, where terms of lease or base rights are inconsistent with extended Air Force tenure, or where agreements restrict operations to other than heavy aircraft.

(3) At permanently established basic-training stations.

(4) At flying fields auxiliary to main bases.

(5) Fighter alert taxiways and other small or limited use facilities provided solely for fighter type aircraft.

(6) For extensions, additions or widenings made to existing understrength pavement which is not to be concurrently strengthened, the design of said increments will match the demonstrated strength of the existing pavement.

(a) Exception: Mass apron additions of 50,000 square yards or more will follow the criteria of 2a (1) (b) or 2b above, regardless of the strength of abutting pavement.

(b) Additional exception: The exception above does not apply to apron access taxiways or to other narrow peripheral additions to existing lower strength parking facilities.

(c) Application of the heavy load design criteria pertains only to pavement strength and will not be construed as requiring additional lengths, widths, or additional paved facilities not required by the assigned mission.

(*b*) Light load design: This design will be used for all airfield pavement to be constructed at all other Air Force installations where it will satisfy the mission requirements. Where additions or extensions are made to existing pavements which do not meet light load criteria, but are otherwise adequate for the assigned mission, the new pavement will be designed to match the strength of the existing pavement. Where existing pavements are substandard or otherwise inadequate for the assigned mission they will be strengthened to light load criteria concurrently with the construction of the addition or extension. For type C wash racks the load will be reduced to 20,000 pounds.

4. Design procedure: Pavement design will be based on procedures set forth in part XII, chapters 2 and 3, of the Corps of Engineers Engineering Manual or the Bureau of Yards and Docks (Navy) Airfield Pavement Technical Publication NAVDOCK TO–Pw–4.

5. Alternate bid schedules: On paving projects where other than portland cement concrete pavement must be considered, the contracting officer will evaluate control estimates for the total project. If, in his opinion, the use of all rigid pavement would not increase the project cost by more than 15 percent alternate bid schedules will be offered. Otherwise, the project will be offered for bid with the flexible pavement items and the rigid pavement items clearly delineated.

Appurtenant construction

This installation engineering criteria memorandum pertains only to pavement constructed specifically for the ground movement of aircraft. Criteria pertinent to stabilized shoulders, stabilized runways overruns and blast erosion control features are contained in separate memoranda.

Implementation (mandatory)

1. The above mandatory criteria will be integrated into current and future programs subject to the following:

(*a*) Fiscal year 1957 and future year program items will be designed in accord with above criteria.

(*b*) Above criteria will be used in design of fiscal year 1956 and prior-year items where construction has not progressed to such a point as to make application impractical.

2. When implementation of above criteria to fiscal year 1956 and prior year program items will require additional apportionment of funds or will jeopardize funding of other facilities in the same program, details will be referred to AFCIE–C prior to implementation. Where application of new criteria in fiscal year 1957 and subsequent programs will result in slippage or deferral of other authorized projects in station programs, report these facts to AFCIE–C promptly in order that information may be used for (1) planning base utilization (2) securing deficiency authorization to cover cost overruns.

Mr. FERRY. Mr. Chairman, I think—if you are satisfied with what we have been able to produce for you, sir, we ask to be excused.

Mr. COURTNEY. Yes.

Mr. FERRY. With thanks of the Air Force for the courteous treatment which has been extended to our witnesses.

Mr. HÉBERT. Just one second. Mr. Miller has an observation.

Mr. MILLER. Mr. Ferry, in view of your statement that you feel that we had traveled rather far afield, I, too, want to see that it is kept on the straight and narrow path.

The thing we are seeking is a cheaper, if there is a cheaper type of pavement, that can be developed——

Mr. FERRY. Yes, sir.

Mr. MILLER. I would like you to express yourself with regard to this statement made by General Wilson. I quote from page 4 of his remarks:

> With regard to future aircraft loadings heavier than the B–52, sufficient work has been done on the design of flexible pavements to indicate that the remaining problems associated principally with asphaltic layer may not be insurmountable. Further investigation is definitely required before any design or construction for these extremely heavy loadings is initiated.

In view of that, doesn't it indicate we can't afford—you can't afford to close your mind when asked to continue this, when the Assistant Chief of Engineers makes that statement?

Mr. FERRY. Sir, we have invested with the Chief of Engineers, and for purposes of experiment—in investigational engineering, since 1952—they have given me a summary. We have $2,150,000 experiment in for rigid paving and $2,528,000 in for flexible pavement.

Mr. MILLER. I may say, in answer to that, Mr. Ferry, that the sixty-some accidents that were reported here just about exceed that amount.

So I don't think that the amount of money that we have spent in experimental work in trying to develop pavements is such a great sum that we should be staggered by it. The $800,000, if $800,000 is the figure—and I agree with you, that you can't pick it out of the air. You should exercise all care and diligence in making sure that no money is going to be expended that is not necessary in this field.

But it surely indicates to me that if it is of the magnitude of $800,000, it is not too great, because as the colonel said in discussing these accidents you could have one accident that would be $1 million. That is very conceivable.

If it looks like we are on the threshold of success, we should pursue it further and should not cut it off at this particular point. Apparently that is what the Air Force seeks to do.

Mr. FERRY. I am in complete accord with the statement Mr. Miller has made there. I, however, ask we do not attempt to tie the cost of airplane accidents to paving, rigid or flexible. I do not think there is too close an analogy.

Mr. MILLER. Well, if there are airplane accidents—and I assume the airplane accidents reported here were airplane accidents that were the result of pavement failure——

Mr. FERRY. No, sir.

Mr. MILLER. I hope we didn't have accidents here that were mechanical failures; that is, due to mechanical failures in the airplane.

Mr. FERRY. That is unfortunately the case. It was breaking accidents on pavings.

Mr. MILLER. That these were due to that. Then with an accident failure that is costing close to $5 million a year—I think that was about the period over which these were taken——

Colonel ALEXANDER. No, sir; it was a longer period.

Mr. MILLER. What? Three years?

Colonel ALEXANDER. Yes, sir.

Mr. MILLER. Even with 3 years— we would certainly be entitled to expend an equivalent amount of money in trying to get a correction of that condition. Don't you think that is reasonable?

Mr. FERRY. I would like to leave it, as to the figure, that I personally will look over the projected experimental and research program that the Corps of Engineers suggests to us and we will exercise the best judgment, with a flexible mind, I hope——

Mr. MILLER. I want to congratulate you, too, Mr. Ferry; you are always a pleasure to have before the committee. You are a good witness and a cooperative one, and one that is not afraid to speak up.

Mr. FERRY. Thank you, Mr. Miller. It is very complimentary.

Mr. HÉBERT. Mr. Ferry, thank you also for coming up. And I will not make a valedictory observation, but only an interim one, and indicate perhaps why I am such a cynic in talking to Department witnesses and representatives. I have been here a long time. I have found out that the rule and not the exception—the departments come in and make the most glowing promises and the most pious statements and walk out the door and forget all about them.

Mr. FERRY. Mr. Hébert, I can only speak as long as I am in my official position as special assistant for Installations, and so responsible for this phase of the Air Force work.

Mr. HÉBERT. I know——

Mr. FERRY. Any statement that I have made today while I am here—I will see that it is carried on.

Mr. HÉBERT. I appreciate it.

Mr. FERRY. If I am not here, I will attempt to leave enough pious intents behind me so others will pick it up.

Mr. HÉBERT. You suffer from guilt by association, Mr. Ferry.

Because it was at the same table that the Department of Defense, only a year ago, solemnly pledged this committee that they would not indulge in negotiated contracts under the so-called Korean emergency. They performed admirably. They did a splendid job. They kept

their word. They reduced it from 93 percent to 92 percent. It was a magnificient contribution, on their promise.

Mr. FERRY. You would pardon me if I make no comment, Mr. Chairman?

Mr. HÉBERT. Yes. Thank you very much.

Mr. FERRY. Thank you, sir.

Mr. COURTNEY. Mr. Chairman, on this safety factor, Mr. Warden is here, and he has a comment which he would like to make on behalf of the asphalt—Bituminous Contractors Association.

Would you come forward, please, Mr. Warden.

His statement is in the record, Mr. Chairman. He called attention to the fact that this would amplify it in view of the testimony this morning.

This is Mr.——

Mr. WARDEN. Warren Warden.

Mr. COURTNEY. Warren Warden, of Warden——

Mr. WARDEN. Miller-Warden Associates.

Mr. COURTNEY. Of Swarthmore, Pa., and other places.

Mr. WARDEN. We have other offices; yes.

Mr. COURTNEY. Sit down, Mr. Warden, please.

Mr. WARDEN. Mr. Chairman——

Mr. COURTNEY. You may be seated.

Mr. WARDEN. Mr. Chairman, our statement was prepared before we heard any of the hearings. We have heard all comments made. None of our statement is to be changed a single word.

I would, however, like to present to the committee a comment with respect to the safety factor, which we think is pertinent, and which is not included in our prepared statement.

Colonel Alexander, may I have the chart that you used? It is a good one.

Colonel ALEXANDER. I believe it is in the counsel's office.

Mr. WARDEN. Oh, well——

Colonel ALEXANDER. Just a minute. We will get them right out to you.

Mr. COURTNEY. I thought they were here.

Mr. WARDEN. Mr. Courtney, I would like to add for the record that while we have been retained to study the issues involved in this problem by the National Bituminous Concrete Association, our company works with both types of pavement and we have no proprietary interest in either of the major products.

I might clarify the record while we have a moment on another point that was raised in one of the previous day's testimony. The percentage of asphalt and asphaltic concrete is 4 percent, about 4 percent by weight. The percentage of portland cement in portland cement concrete is about 15 percent by weight.

Mr. COURTNEY. Let the record show, then, that the witness is about to refer to chart No. 2, which appears in the testimony of Colonel Alexander.

Mr. WARDEN. We would like to point out that the subbase and the base of flexible pavement consists of several feet of a well compacted and dense prepared material, whereas—we still have the wrong chart here. Where is the one with the CBR of 3?

Colonel ALEXANDER. That is it.

Mr. WARDEN. That is it.

Mr. COURTNEY. Let's correct it, then, to say chart No. 1.

Mr. WARDEN. Right. Whereas the rigid consists of a 4-inch mat on a CBR of 3, and no mat on stronger subgrades.

Now, I would like to assume a subgrade weakness which has been cited throughout the hearings, which weakness may be due to faulty design, faulty construction, faulty inspection or to insufficient borings, high water table, poor drainage or moisture from any source. Such as has been cited as occurring at March Air Force Base, where the subgrade down here develops a weakness.

Now, what happens with the flexible pavement in that weakness? As soon as that weakness becomes appreciable, by its very nature, the pavement itself conforms to the depression.

Mr. COURTNEY. The depression in the subgrade?

Mr. WARDEN. Depression in the subgrade, which, as cited at March, Pine Castle, and others, may be due to any one of these causes cited.

On the other hand, as soon as our—let me go back just a minute. As soon as weakness occurs here [indicating], the pavement conforms to that weakness. It becomes evident—the people at the field know at the time—that there is a weakness at that point.

On the other hand, as soon as a weakness appears under the rigid pavement, the rigid pavement then must depend on its structural strength to bridge that weakness.

As time goes on and this area down here becomes weaker, and the washed-out area, if it is that, becomes greater——

Mr. COURTNEY. You are referring to the subgrade now, for the record?

Mr. WARDEN. I am referring entirely to the subgrade.

Mr. COURTNEY. Yes.

Mr. WARDEN. There will occur at some time a situation wherein the portland cement concrete rigid slab will crack or break through to conform to that weakness. I would like to call attention to two pieces of testimony: One is on page 50.

In discussing the failure at March Air Force Base, Mr. Courtney asked this question:

If your subgrade won't support your pavement, it doesn't make any difference what kind of a pavement it is?

Colonel ALEXANDER. That is correct.

Now, then, I submit that this becomes, then, a matter of policy and therefore of concern for not only safety issues but a matter of interpretation of engineering data for the committee. In following that thought, Colonel Alexander, on page 209, in response to questioning by Mr. Rivers, stated:

On this entire item of strengthening for the B–52's, the way they are thinking is until they—

referring to the pavements—

start showing some serious signs of distress, we won't come in for strengthening projects.

(Statement submitted by Air Force is as follows:)

STRENGTHENING

Several of our airfields have pavements designed for 100,000 pounds on dual wheels which will be overloaded as late models of B–47's and B–52's aircraft operate on them at full gross load. It is recognized that some distress in airfield pavements is anticipated for the following reasons:

(*a*) None of the pavements designed prior to June 1955 for the 100,000-pound gear load was designed for channelized traffic such as imposed by B–47 and B–52 type aircraft.

(*b*) Certain pavements in use by heavy aircraft were designed for lesser loads than that noted in paragraph (*a*) above.

(*c*) In some instances, due both to urgency and to the utilization of construction expedients, construction has proven to be of borderline adequacy when subjected to traffic of modern heavy aircraft.

Rather than undertake a major program of strengthening pavements, it is planned to observe the conditions through regular surveys. Accordingly, it is considered that repairs and strengthening will be effected on a spot basis as necessary, priority being given to those bases where the need for strengthening and/or repair is most acute. Since the vulnerability of the heavy bomber airfields to potential distress is recognized, these airfields will be kept under constant surveillance and the areas of incipient distress promptly identified.

In those cases where incipient distress of a serious nature or signs of questionable developments in the pavements are observed, a strengthening program will be initiated.

Mr. WARDEN. In other words, they are not going to strengthen these things until some serious distress occurs.

Now, then, if that is the case, we do have this problem of the serious drop which has occurred with the rigid pavement. Refer to Offut Air Force Base and the damage that occurred at that point. One of our young civil engineers was recently released from the Air Force, and he called our attention to a breakthrough at Harlingen Air Force Base, in Texas, wherein a trailer wheel dropped 6 inches due to this breakthrough.

I would also like to cite General Wilson:

Rigid pavements designed and constructed prior to 1955 for the B–47 loading have shown a minor amount of cracking under the channelized traffic of that aircraft. A more rapid progression of defects on these pavements may be anticipated under the overload of the B–52 aircraft.

Therefore, I submit, gentlemen, that because of the very nature of the flexible pavement the weaknesses show up immediately, whereas the weaknesses over here [indicating] have not yet made themselves as evident, as General Wilson feels, and the rest of the industry feels, that they will become, in spite of the fact that these overloads imposed on flexible pavements show up immediately.

By the very design, there has been less than 1 percent of the total area of all asphaltic concrete pavements constructed by the Corps of Engineers since 1952 on military airfields show any reported indication of distress due to channelized traffic of any type.

In other words, all this conversation about channelized traffic showing up immediately amounts to something less than 1 percent of the total number of square yards of flexible pavement put in by the Corps of Engineers since 1952.

Mr. BATES. Where do you get that figure?

Mr. WARDEN. That figure comes from two places. General Wilson's statement: 105 airfields—I have the numbers in my case; they will be subject to some verification—105 airfields, 10 of which have shown distress from channelized traffic. That is roughly 10 percent.

He further states that the channelized areas are less than 10 percent of an airfield. So 10 percent of 10 percent is less than 1 percent.

We also cite Mr. Kavanaugh's report on Altus, wherein—and that is a much-discussed base, as you will recall—the area affected is one-fifth of 1 percent of the flexible pavement on that base.

I submit, gentlemen, that this safety factor is the real significant safety consideration in comparing the two types of pavement. Such factors as skidding, and so forth, have been—skid resistance—under discussion and have been controversial issues for years in the highway field. The difference between the two pavements is inconsequential for these things.

However, the structural difference, I feel, contains a point which should be of concern to the committee. Thank you.

Mr. MILLER. Mr. Chairman.

Mr. HÉBERT. Mr. Miller.

Mr. MILLER. May I ask a question: Earlier in some of the discussion we heard some stuff about tiring of some of these pavements. Will the rigid tire quickly, more quickly than flexible, or will flexible tire more quickly than rigid?

Mr. WARDEN. Yes; concrete is subject to fatigue. Concrete is also subject to thermal stresses, and other things, which lead us to feel that the increase of thickness beyond current criteria is at least questionable for unreinforced concrete beyond the existing point.

Mr. COURTNEY. Mr. Chairman, may I ask a question there?

You touched on the subject the subcommittee is interested in and had asked questions about. In the testimony so far, as I understand it, none of the airfields in question or under design carry reinforcing material?

Mr. WARDEN. Insofar as I know.

Mr. COURTNEY. Steel.

Mr. WARDEN. That is right.

Mr. COURTNEY. Insofar as you know?

Mr. WARDEN. However, they are experimenting with reinforcing.

Mr. COURTNEY. All right. We are talking about the pavements as they are in place. Would there be any difference in the supporting of the slab shown on the chart No. 1 of Colonel Alexander, to which you have made reference, if it had been reinforced, and would there be a difference in the design?

Mr. WARDEN. Yes, sir. In my opinion, the thickness of the slab could be materially reduced if reinforced, and the slab would be stronger, that is, it would bear a greater load before failure due to overloading. You would then have what would amount to a bridge. That is, we can build bridges 300 feet long or as wide as a highway to just——

Mr. COURTNEY. Then two things follow from that: One, by the use of reinforcing, I take it, you increase the structural strength?

Mr. WARDEN. Yes; that is right.

Mr. COURTNEY. And, two, you reduce the volume of cement that is used?

Mr. WARDEN. Right.

Mr. COURTNEY. That is all the questions I have.

Mr. WARDEN. However, you materially, very materially, increase the costs.

Mr. COURTNEY. Yes.

Mr. HÉBERT. Thank you very much.

Mr. BATES. Those figures which you cited are since 1952?

Mr. WARDEN. Yes, sir. They are in General Wilson's statement, incidentally.

Mr. BATES. You don't have any information as to the frequency of these occurrences recently? The reason I make that statement is this word "channelization" is a new one to me in these hearings, and, if it is a new factor—this weight factor has been something that has only been in the last couple of years—the figures wouldn't be the same.

Mr. WARDEN. While channelization is a relatively new—not a new thing, because it has continued, but an understanding of channelization is relatively new, and in spite of the fact that the failure due to channelization will show up first on flexible pavement, it is interesting to note in General Wilson's analysis of failures that he has 4 airfields cited, a failure of flexible pavement due to deformation of the flexible pavement—not subgrade failure, but of the flexible pavement—and we have 3 of rigid. So, in spite of the lead time that flexible has, the two are quite comparable.

Mr. HÉBERT. Thank you very much, Mr. Warden.

Mr. COURTNEY. Mr. Chairman, General Wilson is here. Then we have the Department of Navy. I hope we can finish both.

Mr. HÉBERT. General Wilson, will you come forward?

Mr. COURTNEY. General Wilson, will you come forward, please?

General Wilson, the committee has one question to ask of you.

General WILSON. Good morning, sir.

Mr. HÉBERT. Good morning, General. You want to introduce this other witness?

Mr. COURTNEY. Oh, yes. This is Dr.——

Dr. TURNBULL. Turnbull.

Mr. COURTNEY. W. J. Turnbull?

Dr. TURNBULL. Yes.

Mr. COURTNEY. Of the experimental laboratory at Vicksburg, for the Corps of Engineers. He has been mentioned frequently in the testimony and is referred to in a number of the exhibits.

Mr. HÉBERT. Mr. Bates, you had a question?

Mr. BATES. General, I think you understood the question I asked. Did you consult with the asphalt industry as to the mixture and how this test down there at Kelly should be worked out?

General WILSON. I can answer that, generally, and then ask Dr. Turnbull to answer it more specifically.

We have always consulted with both industries in our research program. And, when we run into troubles, we consult with both of them. I do not believe we specifically asked them to approve the particular pavement design we used on that particular test. I would like to point out, however, that we are, all of us, enjoying the position of a Monday-morning quarterback on this thing. I am certain the committee is having difficulty in understanding some of these things. I am, myself.

In general, I would like to say that on that test we were directed by the Air Force to make a test, as has been testified, to carry 30,000— or to carry channelized traffic. It is my understanding that we discussed with the Air Force in more detail, and that we felt at that time

that the surface design was adequate. We were worried more about the design of the elements below the surface.

So, it was agreed, probably on our recommendation, that we use the existing criteria, existing as of that date, for this surface. That is why the particular design of the surface was used. In other words, as of that moment in our state of knowledge, we were not concerned about the surface itself as much as we were of the other features, and, therefore, we wanted to find out whether our existing criteria would hold up for the B–47. Again, we are talking of the B–47, whereas today we are thinking in terms of the B–52.

Now, to answer the specific question, I would rather ask Mr. Turnbull, who is intimately connected with that test.

Mr. HÉBERT. Dr. Turnbull.

General WILSON. Did you actually consult with the asphalt industry in that particular?

Dr. TURNBULL. We did not, as such. We had contact with Mr. Griffith, of the Asphalt Institute, at various times, and had discussed the Kelly test. I think that both Mr. Griffith and Mr. Wellborn knew, generally, what the test was.

I corroborate the general's statement, that we placed the asphalt on the Kelly test utilizing our best knowledge at that time.

When the channelization problem first came up, we began studying it, and we realized we had a problem in thickness, total thickness of pavement, in the compaction of the various layers of the pavement, and possibly, in the design of the asphaltic concrete mixture. We did correct the total thickness of the pavement by a certain amount.

Mr. COURTNEY. You mean all layers?

Dr. TURNBULL. Well, the overall thickness requirement.

Mr. COURTNEY. Yes.

Dr. TURNBULL. We did increase the compaction requirements.

Mr. COURTNEY. In the subgrade?

Dr. TURNBULL. Yes. Also in the subbase and in the base courses. In taking a long look at the asphaltic concrete mixture, the only thing that we thought was necessary to meet the channelized traffic was an increase in stability. Now, that increase in stability was in effect at the time of the Kelly test.

But, actually, the difference between the design of pavements for nonchannelized B–47 traffic and for channelized B–47 traffic at the time of the Kelly test was only in the increase of stability requirement.

Mr. COURTNEY. Well, then, if I may jump from the general's answer to the question a moment ago, in his discussions with the committee as to the validity of the Kelly test and who prescribed what, are we to understand for this record that, so far as the Kelly test is concerned, the subbase structures and the compaction of the subgrade on the flexible strip did not suffer any failure by reason of the traffic that was put upon it?

Dr. TURNBULL. That is right. At the completion of the test, there was no distress below the asphaltic concrete pavement.

Mr. COURTNEY. So, then, what we are talking about in terms of failure, is the 5 inches of overlay?

General WILSON. Yes, sir.

Mr. COURTNEY. Of asphalt which rutted or which did something else?

Dr. TURNBULL. That is correct.

Mr. COURTNEY. That was put in on existing—the mix was determined on existing design criteria for that 5 inches; is that correct?

Dr. TURNBULL. Yes, sir.

Mr. COURTNEY. And there may well, then, have been a difference of opinion as to whether or not the mix should have been different in the 5 inches on top?

Dr. TURNBULL. That is right.

General WILSON. I am——

Mr. COURTNEY. Is that right?

General WILSON. I am not too sure there was a great deal of opinion on Saturday. There was a lot on Monday.

Mr. COURTNEY. Well, whatever differences of opinion.

Dr. TURNBULL. I am speaking as of that time.

Mr. COURTNEY. All right.

Dr. TURNBULL. There was no difference of opinion voiced to us. We all were of the same opinion that the asphaltic concrete would do the job.

Mr. COURTNEY. Whatever we are talking about in terms of the Kelly test failures or whatever inferences you were to draw from them, are related solely to the question of the mix of the 5-inch overlay?

Dr. TURNBULL. Yes, sir.

General WILSON. Yes, sir.

Mr. COURTNEY. Is that right? Otherwise the test was a satisfactory test for what you were designing it for, no matter whether you put 30,000 or 15,000 loadings, is that right?

Dr. TURNBULL. That is right.

Mr. COURTNEY. Are we to understand that for the record?

General WILSON. Yes, sir.

Mr. BATES. I am not so sure I understand the answer to my question, Mr. Chairman, as to why the Army engineers did not consult with the industry. You contacted them. That doesn't mean you asked their opinion.

Dr. TURNBULL. In our capacity at the Waterways Experiment Station, those questions are often referred to the Office, Chief of Engineers. However, in this case, we had informal contact with the Asphalt Institute. To my knowledge that contact did not bring forth any comments about the Kelly test, that is that the asphalt content was too much, or otherwise.

Subsequent to the failure of the test section at Kelly, of the asphaltic concrete, the Asphalt Institute was invited officially by the Office, Chief of Engineers, to participate in all further testing and design of high quality mixes for these very heavy wheel loads.

Mr. BATES. That was after the fact. For the Kelly tests, they were observers; is that correct?

Dr. TURNBULL. I would say that was correct.

General WILSON. Mr. Bates, may I say we have a good many tests running in various places. I believe the institute and others in the industry will indicate that we have always welcomed any suggestions they have made and we have kept them informed of what we are going to do.

Mr. BATES. Well, of course that is the purport of my question, General.

General WILSON. Right.

Mr. BATES. I just want to be assured that the Army engineers is not closing the door on the industries when they have some substantial recommendations to make.

General WILSON. That is correct.

Mr. BATES. As I recall the testimony, they contacted someone in the engineers who ignored their recommendations.

General WILSON. Well, I would like to clarify that a little bit, too, sir. Two things.

No. 1: The question of whether we notified the Air Force of the offer to pay—we did not. The amount of money involved in replacing this surface layer in this small test section is around $1,000. We had ample money to do it ourselves.

The amount of money involved in trafficking runs up closer than 30—I am not certain of the exact figure, but up around $30,000. We had that available. We did officially ask the Air Force for authority to go ahead and put in another surface and they told us that wasn't necessary.

I would like to amplify it. When I say "officially," I mean informally. Members of the staff of the Chief of Engineers discussed with the staff of the USAF and were told not to spend any more money on that particular test.

Now, to go to the other point. We have gotten suggestions from the Asphalt Institute. They are being tested. Tests have been completed on some of them.

The Monday morning quarterbacking on the Kelly test, that said "It is obvious what was wrong here is what you should do"—I think there were four particular designs that they furnished that are being tested, and I believe that 3 of the 4 have failed under much less than 30,000 coverages.

Now, Dr. Turnbull can give you more accurate information on that.

Mr. BATES. Now, I am not sure to whom they made these recommendations.

General WILSON. To the——

Mr. BATES. Before the Kelly test.

General WILSON. They didn't make them before the Kelly test.

Mr. BATES. As I understand they contacted someone there who practically ignored them.

Dr. TURNBULL. May I, Mr. Bates, try to answer that question? I don't believe you could say the recommendations made by Mr. Griffith were before the test. On the 17th of April 1956—now, this is Mr. Griffith of the Asphalt Institute—called to the Waterway Experiment Station protesting the use of this additive in the asphaltic concrete mixture. And we were well aware of course that the Asphalt Institute, as the testimony has shown, does not favor the use of additives.

However, we did have reasons. Now, that was too late, in that on the morning of the 17th paving commenced at Kelly and prior to that the additive had already been added to the asphaltic mixture.

Now, on the 26th of May Mr. Griffith called, stating that the stability values of the asphaltic concrete which we were using—that is, their prepared laboratory mixes—were low.

Now, there was considerable discussion between our Vicksburg laboratory and Mr. Griffith concerning the possibilities and reasons for these low stabilities.

And we, in our own opinion, feel that there was some differential between their laboratory procedure and ours, in that their laboratory specimens were a little bit less dense than ours—about 3 pounds per cubic foot on the average.

However, this call on the 26th of May was also after the fact.

But I do repeat that even as of the 2d of February Mr. Griffith visited us at the station and the Kelly test was discussed and no comments made that we were using the wrong procedures.

Mr. BATES. Did he know what procedure you were going to use?

Dr. TURNBULL. At that time we had only tentative design. We did not finalize our design—as a matter of fact the design was not completely finalized until we moved out of the Kelly area and the contractor had all of his equipment together and his gravel material stockpiled. At that time the final plant mix design was made.

Mr. BATES. It would be pretty difficult for an outsider to know ahead of time, if you didn't know yourself, what mixture you were going to use, until that late date.

Dr. TURNBULL. We knew generally what it would be, premised on our laboratory design. But that, Mr. Bates, is the normal procedure on any asphaltic concrete. The final design is effected when the contractor assembles his plant equipment and actually produces his stockpiles of material.

Mr. BATES. I don't believe we should criticize somebody on the outside for not giving suggestions.

Dr. TURNBULL. We are not.

Mr. BATES. When they didn't know——

Dr. TURNBULL. We are not, sir.

Mr. BATES. When they didn't know what you were doing, or say they come in so late.

General WILSON. No, sir, we are not criticizing them. I am trying to make the point, however, that Monday morning it would be obvious to our people as well as the others what the fault had been and we did ask them or permit them to give us certain designs to be tested, and we have tested those, and they have also failed.

Mr. BATES. You have done that since that time?

General WILSON. Yes, sir.

I would also like to point out that we have tested some designs with additive as opposed to those without additive and the additive has done as well—the one with the additive has held up as well as the one without the additive. So I don't want you to get the wrong impression from some of the testimony that has been given.

Mr. BATES. I won't belabor the point. The only reason I bring it up is that in the future, if there hasn't been cooperation in the past, I hope we will have that cooperation in the future.

General WILSON. We can assure you we intend to, because it is cheaper for us to get advice from them for free than to go out and pay for it.

Mr. BATES. Or waste all your time up here.

Mr. HÉBERT. Thank you again, very much, General. I admit we are Monday morning quarterbacking, but we have our eyes on next Saturday's game.

General WILSON. Yes, sir. There were other points raised——

Mr. HÉBERT. Yes, General, we want the record to be complete.

Mr. COURTNEY. Go ahead, General.

General WILSON. I believe we have a design, as was stated in my opening statement, and repeated under questioning for asphaltic or flexible pavement, for the B–47 now. If that is a question of issue. I don't believe it is a question of issue because I think we should be designing and building for the 52.

I am confident that we can build interior portion of the runway out of asphaltic concrete today, if that is desired. And I am pretty certain that the Air Force is aware of our position on that matter.

So this business of having the Air Forces wait until we come to them with a certified copy of a design and say, "This will hold up under the worst loads and therefore we can't use it anyplace else"—I don't feel that we should remain silent on that.

My own reaction would be—in playing safe—to increase the ends of the runways to maybe 1,500 feet of rigid on each end and that then you would be safe to produce the interior out of asphaltic concrete, if that would actually prove to be cheaper.

As I pointed out the other day, if there is only a limited amount of one type of material to be used, it may not be cheaper to use it, because you bring in different equipment.

Mr. COURTNEY. That would be a matter of bidding, wouldn't it, General?

General WILSON. It would be a matter of bidding if we asked for alternates.

Mr. COURTNEY. Yes.

General WILSON. Or if our experience in that vicinity and on other jobs would indicate it wasn't worth putting everyone to that extra expense. We might not ask for it in that event.

Mr. HÉBERT. Mr. Ferry, what reply do you have to that observation that the general made?

Mr. FERRY. I do not know upon what test judgment General Wilson bases his view that the interior portions of the runway could safely be made of asphaltic concrete.

So I hesitate to comment as to the reasons behind it.

All I say: The Air Force is not yet convinced from any evidence that has been presented to us that the interior portions or the central portions of runways made of flexible pavement can withstand the channelized traffic resulting from the rolling of heavy B–52's for an extended period of time. I am not yet convinced of that.

Mr. BATES. Well, how would you become convinced of that, Mr. Ferry? The asphalt industry says it can be done. The general here in charge of the engineers, in that capacity, says it can be done, if you only desire it.

Mr. FERRY. I would like to see some evidence presented in the form of an accelerated test to substantiate that opinion, sir.

Mr. HÉBERT. Let's have the test.

Mr. FERRY. With the greatest of pleasure.

Mr. HÉBERT. Well, all right. Will you have such a test?

Mr. FERRY. I will have such a test, sir, as soon as General Wilson and his people come up with what they say is a design that will stand this requirement.

Mr. HÉBERT. General Wilson, will you come up with that design?

General WILSON. We have that design, sir.

Mr. HÉBERT. Will you give it to the Air Force?

General WILSON. Yes, sir. But may I comment on that, sir?

Mr. HÉBERT. How long have you had it, General?

General WILSON. In our opinion, for the central portion of the runway, we have had it a long time. Because, as has been testified here, the airplane is partially airborne by the time it reaches the end of some point.

Now I concur with the Air Force entirely, in that I want to be certain on that point. It was originally 500 feet. It has been extended to 1,000 feet.

It is my understanding that certain—not tests, but examinations or investigations of what has been happening would indicate that 1,000 feet is still safe, but the load is still pretty heavy out pretty close to that. So, to play safe, I would rather move it longer.

Mr. COURTNEY. That is on takeoff.

General WILSON. On takeoff. On landing, you don't have the load. So, one of the elements of channelized traffic is materially reduced on a plane that is landing, in that it is no longer a heavily loaded plane as opposed to one taking off.

However, to conduct a test on the center portion of a runway under conditions of an airplane being partially airborne is going to be a rather extremely difficult test, Mr. Chairman. We would have to discuss that with the Air Force. I am not too certain that we can devise a test, with their best judgment and ours, that would actually prove anything. Because we couldn't simulate that, I don't believe. You can, on the place you are testing the heaviest load. It could be calculated, I suppose, what weight there would remain as a result of the thing being partially airborne, and, if they will agree with us on what that is, I think we will find that previous tests have already demonstrated the carrying capacity for that weight.

Mr. HÉBERT. And that would bring into a competitive area the rigid against the flexible.

General WILSON. Merely in that one section.

Mr. HÉBERT. That is all right. But that still would save money, wouldn't it?

General WILSON. In some instances, in many instances, but not in all instances, I don't believe.

Mr. HÉBERT. Even if as much as a penny is saved, it will be saved without affecting the safety factor.

General WILSON. Yes, sir.

Mr. HÉBERT. Well, I am glad to formally introduce you, General, to Mr. Ferry. I want to introduce you not on a personal basis, but introducing you to the engineer's concept here. The committee will be interested to know what will become of this particular feature.

General WILSON. Mr. Chairman, that will not apply to taxiways, because on the taxiway on either end of the runway you can have and do have the fully loaded plane.

Mr. HÉBERT. We understand that.

General WILSON. But, as we indicated the other day on the testimony, it is conceivable that a fairly narrow rigid strip, or fairly narrow strengthened strip—at the moment we agree with them it

should be rigid—would be capable of doing it, with the remaining widths in the flexible pavement.

Mr. HÉBERT. General, the committee will formally ask you to discuss this with the Air Force formally and report back to us formally.

General WILSON. All right, sir.

Mr. HÉBERT. How long do you think it would take you to have these formal discussions, so we will know what we are talking about?

General WILSON. Well, tomorrow happens to be a holiday, sir.

Mr. HÉBERT. We don't expect that much speed.

General WILSON. No, sir. I imagine we could give you a reasonable answer in about 2 weeks. Will you agree with that?

Mr. FERRY. I think so.

Mr. HÉBERT. We will give you 3 weeks.

General WILSON. All right, sir.

Mr. HÉBERT. We will say August 1 we would like a report on that conference.

General WILSON. All right, sir.

Mr. HÉBERT. The committee would like a report on that conference.

General WILSON. All right, sir.

Mr. HÉBERT. Thank you very much, General.

The committee will stand in recess subject to call of the Chair.

(The following letter was received by the chairman:)

THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA, INC.
Washington 4, D. C., May 15, 1957.

Subject: Hearings relating to airstrip-paving criteria to be held by subcommittee for special investigations.

Hon. F. EDWARD HÉBERT,
Chairman, Subcommittee for Special Investigations, Committee on Armed Services, House of Representatives, Washington 25, D. C.

MY DEAR CONGRESSMAN HÉBERT: Thank you for the invitation extended this association in your letter of May 6, 1957, to participate in hearings scheduled by the subcommittee relating to airfield-paving criteria.

We have taken steps to notify our membership of these hearings, and you will no doubt be receiving inquiries and requests for information from individual contractors or local groups who desire to participate.

This association does not feel that it has any information which would contribute materially to the studies being made by the subcommittee, and for this reason we respectfully decline the invitation to actively participate in the hearings at this time. We will be pleased to assist your group in any way possible, and would appreciate being informed of the results of the studies being made.

Sincerely yours,

JAMES D. MARSHALL,
Executive Director.

(Whereupon, at 12:08 p. m., the subcommittee adjourned, subject to call of Chair.)

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BOEING AIRPLANE CO.–FORD MOTOR CO.— PURCHASE ORDER SUBCONTRACT ON AF 33–600–5148

MAIN READING ROOM

REPORT AND HEARINGS

BEFORE THE

SUBCOMMITTEE FOR SPECIAL INVESTIGATIONS

OF THE

COMMITTEE ON ARMED SERVICES HOUSE OF REPRESENTATIVES

EIGHTY-FIFTH CONGRESS

FIRST SESSION

UNDER THE AUTHORITY OF

H. Res. 67

HEARING HELD ON MARCH 29, AND JULY 12, 1957

Printed for the use of the Committee on Armed Services

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REPORT

BOEING AIRPLANE CO.—FORD MOTOR CO. SUBCONTRACT

On March 29, 1957, the General Accounting Office presented to the subcommittee its findings and conclusions made after investigation of a purchase order subcontract issued by Boeing Airplane Co. to Ford Motor Co., Kansas City division. That testimony is printed in full as a part of this report. Briefly, the facts presented are these:

Under Air Force prime contract No. AF33(038)–21407, issued to Boeing Airplane Co., purchase orders were issued to the Ford Motor Co. for B–47 wing sets and by change order No. 13, dated November 27, 1951, to Boeing purchase order No. 952359 and change order No. 12, dated March 27, 1952, to Boeing purchase order No. 952360, the subcontracts were transferred from contract No. 21407 to Air Force contract AF33(600)–5148. These wing sets were purchased for the use of Boeing and for distribution to its coproducers, Douglas Aircraft Co. and Lockheed Aircraft Co.

We are given to understand that a suggestion to subcontracting with Ford was made by the Department of the Air Force.

Purchase order No. 952359 was a price redeterminable contract. It had a gross value at the time of issuance of $139,449,807.

At the time of redetermination, the estimated profit percentage was 8.9 percent. On an estimated cost of $60,389,367, a profit of $5,348,754 had accrued to Ford Motor Co.; and for the balance of the contract on estimated costs of $67,009,674, a profit of $6,702,012 (10 percent) was expected.

Against a selling price of $139,449,807, actual costs amounted to $117,712,407 and generated an overall profit on the entire transaction of $21,880,504 or 18.6 percent, double the initial projected percentage.

The purchase order contract provided for a retroactive and prospective price determination upon delivery of a minimum of 40 percent and a maximum of 70 percent of these wing sets.

But the contract also provided that the time of redetermination could be changed by mutual agreement. Accordingly, on April 1, 1952, before any wing sets were delivered, the price redetermination time was moved up to the 127th wing set (or 28 percent of completion instead of 40 percent) so that Boeing could submit its own figures to the Air Force.

When the 127th wing set had been completed, Ford requested that the redetermination point be moved back to the original time or 39 percent of completion because delivery time had been extended from 18 to 24 months.

Ford pointed out that the extension of the delivery schedule from 8 to 13 months would increase the possibility of variance from the forecasted price.

Exhibit D of November 21, 1953, stated that—

> it was our understanding that consideration would be given to altering the end of the first pricing period * * * should there be any significant change in the shipping schedule.

Ford stated—

it is our feeling that consideration should be given to reestablishing determination at 39 percent on January 31, 1954.

Boeing declined. It stated that under one of its Air Force contracts, No. 5148, it was required to submit cost data to the Air Force by December 29, 1953, for price negotiations on the B–47 and that it was "imperative" that fixed prices with Ford be determined.

Ford then submitted cost estimates on December 16, 1953, January 15, 1954, and February 19, 1954, respectively.

The General Accounting Office expressed the opinion that the redetermination of the Ford subcontract was made before sufficient production experience had been gained. As a result, Ford stood to earn 28.9 percent profit on 272 sets compared to a profit of 10 percent originally projected.

General Accounting Office observed that there seemed to be no necessity for Boeing's insistence upon moving the point of price determination forward from 39 percent of completion to 27 percent and that provision could well have been made for further adjustment. Boeing itself readjusted $2,047,854, indicating that target price was considered subject to further revision. Thus, Boeing's contention that it could do nothing about revision of the contract appears to be without substance. It had itself accomplished a revision downward in the contract.

The position of the Air Force in this transaction is unusual; $5 million of savings scarcely got 5 cents worth of attention from higher echelons.

Maj. George F. Newton was an Air Force contracting officer and Air Force representative at Boeing Airplane Co.'s plant in Wichita, Kans. He early foresaw that excessive profits would accrue and brought the facts to the attention of his superiors and Boeing.

On three separate occasions, his warnings were dismissed upon the grounds that they were "only the opinion of this officer." Had his voice penetrated the barrier between echelons, the knowledge that excess profits were in the making, far beyond the amount contemplated in forming the original contract, could have been determined early.

To us the evidence is overwhelming that neither Boeing nor the Air Force had any enthusiasm for or interest in reconsidering the pricing in this contract and the recoupment of excess profits until the General Accounting Office intervened.

But when the General Accounting Office report with the letters exchanged between the parties was published, Boeing protested the interpretation which the public had placed upon the facts reported in the public press by responsible news services.

The subcommittee advised Boeing to resolve any alleged differences on facts with the General Accounting Office. That was done. A "memorandum of understanding" was reached. It is a part of this record. Stripped of excess verbiage it was agreed that the General Accounting Office had correctly determined both facts and figures. An error had occurred in the numbering of the contract.

An excess profit greater than contemplated by the parties in forming this contract was earned. Change in redetermination dates was to some extent responsible for possible errors in cost data. But what-

ever the cause when the fact that excess profits were about to be earned was brought to the attention of Air Force officials by Newton, he was ignored by his superiors and Boeing.

It is regrettable that when so much money and so much trust is placed in concerns performing work for the United States that it does not generate a more active concern for those who are footing the bill. When retrenchment occurs and orders are canceled, these firms will be the first firms to cry out over the lack of work and beat their breasts over the dangers in defense cutbacks. The squandered dollars might well have been insurance against cutbacks.

As to the facts there is little room for dispute and almost none for disagreement. Members of this subcommittee are in complete accord with what Boeing complains is the interpretation placed upon its conduct. Boeing, the Air Force, and Ford made that record.

The only clear and steady light in this whole spectacle of ducking and dodging was by Major Newton whose warning was dismissed as "only an opinion"—an opinion worth more than $5 million at the time it was issued.

If the severity of the judgment of the American public has been visited upon these parties we think it earned by their conduct. We reach the same conclusions attributed to the American people.

The appreciation of this subcommittee and of the Congress is due the representatives of the General Accounting Office who have presented these facts and stimulated the activity which finally recouped $5 million.

We adopt the conclusions and recommendations of the General Accounting Office as the recommendations of the subcommittee.

Approved unanimously by the subcommittee, August 14, 1957; ordered printed and published.

F. EDWARD HÉBERT,
Chairman, Subcommittee for Special Investigations.

Approved August 14, 1957.

CARL VINSON,
Chairman, Armed Services Committee.

BOEING AIRPLANE CO.–FORD MOTOR CO.—PURCHASE ORDER SUBCONTRACT ON AF 33–600–5148

FRIDAY, MARCH 29, 1957

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE FOR SPECIAL INVESTIGATIONS,
Washington, D. C.

The subcommittee met at 10 a. m., the Honorable F. Edward Hébert, chairman of the subcommittee, presiding, with the following members present: Mr. Hess, Mr. Gavin, Mr. Cunningham, Mr. Bates, Mr. Hardy, Mr. Osmers, and Mr. Miller.

Mr. HÉBERT. The committee will come to order.

Members of the committee, since the recess of yesterday we were compelled to change our schedule, as the Recony testimony was to have been followed through today, but, because of the number of witnesses involved, and with the desire of having a continuity in the presentation of that testimony, it was thought best that we interrupt that particular phase and extend it over to Monday, and enter at this point the present discussion which I will outline now and which was authorized by the committee previously.

This is in connection with the Boeing purchase order 952359, contract AF–33–038–21407, a contract between Boeing Airplane Co. as Air Force prime contractor on the above-numbered contract, and the Ford Motor Co.

Now, in its report to the subcommittee in the 84th Congress reporting on this contract, data supplied by Boeing Airplane Co., commencing at page 1896 and following, contained no reference to this Ford Motor Co. contract, although the specific question was asked concerning subcontracts in excess of $100,000.

The distinction is apparently made that a purchase order is not a subcontract but accomplishes the same thing under another name. The item is presumably carried and reported to the subcommittee on page 1897 under "Production material and purchased equipment of $165,520,751." These elements are computed upon the basis of direct costs.

This contract had an initial selling price of $139,449,807 when it was entered into on July 1, 1951. It was for the purchase of 454 wing sets of the B–47 airplane.

The General Accounting Office has made a review and audit of this contract, which is designated for distinction but not for difference as a purchase order.

In the course of the operation of the contract, the profit rose from an estimated target of 10 to 28.9 percent. The Ford Motor Co. protested the method of redetermination, as will more fully appear, and

90676—57——2

has refunded voluntarily to the Government, without any insistence therefor or even interest therein by either the Department of the Air Force or Boeing Airplane Co.

We have before us this morning Mr. Lawrence J. Powers, the Director, and Mr. William A. Newman, Jr., the Deputy Director of General Accounting Office, Division of Defense Accounting and Auditing. A written report has been presented to the chairman.

Correspondence has been conducted by the General Accounting Office in relation thereto between contractor and the Department of the Air Force, which will be detailed in the course of this presentation.

Mr. Courtney?

Mr. COURTNEY. Mr. Chairman, in addition to Mr. Powers and Mr. Newman who have the prime responsibility in this matter we have assistants in that Department, and the regional director—Mr. Hammond, James A. Hammond, and Mr. L. E. Murphy, who is the regional manager for General Accounting Office covering the Kansas City area. Now, Mr. Powers, will you proceed, please?

The committee may be advised that the report, to which reference was made in the chairman's statement, is in your hands.

The figures which appear on the bulletin appear on the first page of the report, and are put up there for your convenience. Proceed, sir.

Mr. POWERS. Mr. Chairman and members of the Subcommittee for Special Investigations of the Committee on Armed Services, we appreciate the opportunity to appear before your subcommittee at your request to explain our report on Boeing Airplane Co. purchase order 952359, being a subcontract of Air Force contract 33(038)-21407, which was forwarded to the Honorable Carl Vinson, chairman, Armed Services Committee, by the Comptroller General of the United States on February 8, 1957, in response to your letter of February 7, 1957, and referred to your subcommittee.

We understand your committee is now considering negotiated contract procurement methods in connection with remedial legislation or regulation that is deemed to be desirable.

We further understand that your committee has initiated an inquiry into subcontracting by the major prime manufacturers supplying the military.

I would like to say to the committee, Mr. Chairman, that the Comptroller General has been deeply concerned in this matter from the standpoint of protection of the Government's interests and efficient and economical military operations. Over a year ago the Comptroller General directed that our audit of negotiated contracts for defense procurement be accelerated as rapidly as possible.

Mr. Chairman, I would also like to emphasize that the primary objective of our audit is to obtain consideration as to the necessity for improvements in management controls for defense contract administration and contractor operations.

Our discussion here this morning is concerned with the financial results of our review of a negotiated subcontract executed by the Boeing Airplane Co., a prime manufacturer, and the Ford Motor Co.

In this case, the prime contract between the Department of the Air Force and the Boeing Airplane Co. is a fixed-price, incentive-type contract which provides for the adjustment of profit and price based upon the relationship which final negotiated total cost bears to negotiated target cost. The subcontract executed by the Boeing Airplane Co.

with the Ford Motor Co. was a fixed-price type of contract subject to redetermination at a point agreeable to both parties.

Boeing Airplane Co., Wichita, Kans., awarded to Ford division of Ford Motor Co., Kansas City, Mo., purchase order 952359 (contract AF 33(038)-21407) dated July 10, 1951, for the production of 454 wing sets for B-47 airplanes and purchase order 952360 dated July 9, 1951, for special tooling.

Boeing had been designated by Air Materiel Command (AMC) as technical primed contractor with responsibility for negotiating prices for B-47 wing assemblies supplied by Ford to Boeing Airplane Co., Douglas Aircraft Co., Inc., and Lockheed Aircraft Corp.

The above-mentioned purchase orders were issued by Boeing in accordance with AMC's suggestion that Ford be utilized as a source of supply of B-47 wing assemblies to Boeing, Douglas, and Lockheed.

Our review was primarily concerned with the financial results of purchase order 952359 (contract AF 33(038)-21407) for the 454 wing sets A comparison of the cost and profit realized by Ford with that contemplated in price revision negotiations of this purchase order is shown on the blackboard, Mr. Chairman, and is contained at the top of page 2 of our report.

You will note that the selling price and the cost at the redetermination point was $139,449,807 and $127,399,041, respectively, with a contemplated profit of $12,050 and $12,050,766, which represented a profit of 9.4 percent in relation to projected costs.

The actual experienced cost of Ford Motor was $117,712,407, compared with the selling price of $139,600,911, and they realized a profit of $21,888,504, or a net profit of 18.6 percent of the actual cost.

This difference was approximately $9,837,738 above the profit contemplated at the point at which the contract price was redetermined.

(The full table is as follows:)

	Selling price	Cost	Profit	Profit percentage
Established in redetermination:				
Retroactive portion	$65,738,121	$60,389,367	$5,348,754	8.9
Prospective portion	73,711,686	67,009,674	6,702,012	10.0
Total	139,449,807	127,399,041	12,050,766	9.4
Experienced:				
Retroactive portion	65,738,121	60,389,367	5,348,754	8.9
Prospective portion	73,862,790	57,323,040	16,539,750	28.9
Total	139,600,911	117,712,407	21,888,504	18.6
Difference	[1] 151,104	−9,686,634	9,837,738	

[1] Increase in selling price due to change orders issued after redetermination.

Mr. POWERS. Air Force contracting personnel did not participate in the selection of the point at which prices would be redetermined for purchase order 952359, nor did they take an active part in redetermination negotiations. Our review showed that Ford realized profits substantially higher than those contemplated in negotiations. We believe that this resulted chiefly because redetermination was made before sufficient production experience and related costs had been obtained and that closer control by AMC over price redeter-

mination in this case would have resulted in the establishment of a more equitable price.

Purchase order 952359 between Boeing and Ford provided for a simultaneous retroactive and prospective price redetermination at delivery of between 40 and 70 percent of the wing sets.

The agreement also provided that the point for redetermination could be changed by mutual agreement between the parties.

On April 1, 1952, prior to delivery of the first wing set by Ford, Boeing and Ford agreed that the price revision point would be delivery of the 127th wing set, which constituted 28 percent of the wing sets to be delivered.

In November 1953, Ford wrote to Boeing, stating:

In the meeting held at Wichita on April 1, 1952, attended by representatives of Boeing and Ford, it was agreed, with regard to the fixing of wing pricing periods, that the first pricing period be established at the delivery of the 127th wing set. However, in reaching this agreement, it was our understanding that consideration would be given to altering the end of the first pricing period should the total number of wing sets be increased or decreased, or should there be any significant change in the shipping schedule.

The Composite Sequence Shipping Schedule, No. 11–R–8 dated October 8, 1953, provides for a reduction in the production rate of wing sets per month and thus extends delivery over a considerably longer period of time. This has caused us to reanalyze the advisability of retaining the 127th wing set point for redetermination, and as discussed with you recently, it is our feeling that consideration should be given to reestablishing the point of redetermination at January 31, 1954, at which time approximately 39 percent of the total wing sets on order under the basic purchase order will be delivered, based on the current Composite Sequence Shipping Schedule referred to above.

Our proposal is primarily based on the following two considerations:

1. The shipping schedule in effect at the time the above agreement was reached provided for delivery over an 18-month period. The 127th wing set was to be delivered during the 10th month, thereby fixing the duration of the second pricing period at 8 months. The current shipping schedule requires delivery of the same total of wing sets over a 24-month, rather than an 18-month period. This schedule contemplates that delivery of the 127th wing set will be completed during the 11th month, but extends the duration of the second pricing period, by 5 months, to 13 months.

The extension of this period, during which a fixed price will apply, will increase the possibility of variance from the forecasted cost-price relationship. This situation would be somewhat alleviated by redesignating the end of the first pricing period at January 31, 1954, as proposed, and thereby reducing the second pricing period to 11 months.

2. This revision would be of mutual benefit, since it would make additional cost experience available for consideration in the establishment of equitable redetermined prices.

In view of the above, we request that the effective point of price redetermination be reestablished by mutual agreement at January 31, 1954, when approximately 39 percent of the total wing sets on order under Boeing's purchase order 952359, Lockheed purchase order J2–00001, and Douglas purchase order OMID–9005 are delivered.

Boeing declined to extend the effective point of redetermination, stating:

Boeing is obligated, under provisions of its prime contract AF33 (600)–5148, to submit cost data to the Air Force by December 29, 1953, to be used as a basis for negotiating prices for B–47 airplanes ordered thereunder. Tentatively, the time established for our prime price negotiation has been set for early February 1954, therefore, it is imperative that we have your statements of cost and proposed fixed prices on schedules in accordance with the present agreement.

This communication from Boeing back to Ford, is contained as appendix C to our report.

To meet its commitment to the Air Force, Boeing requested Ford to furnish preliminary cost estimates, which Ford submitted on December 16, 1953. In compliance with the terms of the Boeing-Ford agreement, which provided for redetermination of prices after delivery of the 127th wing set, Ford submitted on January 15, 1954, its price redetermination statement of costs and proposed prices.

In negotiations concluded on February 19, 1954, Boeing and AMC agreed upon a revised target price for Boeing's prime contract with the Government for B–47 airplanes. The price was based in part on the redetermination cost estimates submitted by Ford to Boeing on January 15, 1954.

In price redetermination negotiations completed on March 20, 1954, for purchase order 952359, Ford and Boeing agreed upon a firm price for the entire 454 wing sets. The negotiations, at which Air Force contracting officials were present as observers only, were based on Ford's statement of costs and proposed prices submitted January 15, 1954, which reflected experience through November 1953, when the 127th wing set was delivered.

After the price of the Ford-Boeing subcontract had been redetermined, Boeing informed AMC on April 29, 1954, that on the basis of more complete cost information Boeing had negotiated a price for wing assemblies which was $2,047,854 less than that contained in the negotiated target price of Boeing' prime contract. Accordingly, Boeing recommended to AMC that its incentive target price be reduced by $2,047,854.

We believe that redetermination of Ford's subcontract price was made before sufficient production experience had been gained by Ford to enable the parties to estimate future cost trends with reasonable accuracy and therefore the redetermined price was higher than warranted.

As a result, as shown on the blackboard, Mr. Chairman, Ford realized a profit of 28.9 percent based on incurred costs on the forward portion of the contract (327 wing sets) compared to a profit of 10 percent agreed upon in negotiations.

No provision was made in the redetermination settlement with Ford for further adjustment of contract prices should results show that the redetermined price was not reasonable, even though the contracting parties were not in agreement as to the most opportune point for establishment of a forward price.

In response to our inquiry submitted to the contractor through the Contracting Officer's representative, Boeing Airplane Co. informed us that it never expected to negotiate a redetermined price with Ford prior to setting a revised target price for its prime contract but that—

> * * * it was considered essential to time the negotiation with Ford so that data in support of the pending subcontract negotiation could be used as a basis for Boeing's prime contract negotiation.

The position of Boeing on this matter is attached to our report as appendix B.

While it is normally essential that subcontract prices be fixed prior to negotiation of final prices of prime contracts, there seems to have been no necessity for Boeing's insistence on obtaining from Ford the latter's price redetermination cost proposal for negotiation of a revised target price for Boeing's prime contract with AMC.

A revised target could have been set from the preliminary cost estimates previously furnished by Ford to Boeing. In establishing this target price, provision could have been made for adjustment for differences between the preliminary cost estimates furnished by Ford and the price subsequently negotiated for the Ford subcontract work. In fact, Boeing's latter request to the Air Force for downward adjustment of its revised target price to reflect the $2,047,854 difference between Ford's proposed subcontract price, and the actual price negotiated by Boeing with Ford indicates that the revised target price was considered by Boeing as subject to revision even after it was established. Thus Boeing's above-stated contention does not appear to be a sound basis for insisting on use of cost data and a pricing proposal which had been indicated by Ford as premature and would possibly result in greater price variances.

In its letter to us, Boeing also took the position that, when Ford requested an extension of the price redetermination date—

> * * * it was considered by Boeing to be another attempt on the part of Ford to extend the experience period, thereby allowing more cost to be recorded prior to the negotiation date, which would reduce the risk area in the prospective pricing period.

According to Boeing, such an extension—

> * * * would have been contrary to the true concept of the Department of Defense Title II–B price redetermination subcontract.

We feel that, when sufficient cost experience has not been obtained to enable a reasonably accurate estimate of production costs, there should be an adjustment in the redetermination point, as suggested by Ford, particularly when the contract provides for only one price redetermination, as in this case.

We believe that Ford's cost experience at the redetermination point was not adequate for establishing reasonable contract prices and that redetermination based on later experience would have been equitable to the Government.

Further, we believe that the substantial additional profit realized by the subcontractor in this case clearly demonstrates the need for more effective control by the Air Force over negotiating points and prices negotiated between prime contractors and major subcontractors.

Our findings and observations, which have been explained to the committee, were submitted to the Air Materiel Command for comment, and a detailed reply was received. Their reply, dated July 17, 1956, is attached to our report, as appendix F.

The substance of AMC's comments was that Ford realized profits in excess of those contemplated because of faulty cost projections and weaknesses in negotiations and because of outstanding efficiency by Ford during the latter stages of production. AMC took the position that repricing of Ford's subcontract by Boeing was not premature, as sufficient information was available for establishing firm fixed prices, but that the negotiators failed to make optimum use of the available data. According to the AMC, Ford's cost projections as regards costs of materials and subcontract items and labor were unrealistically high and the negotiators failed to recognize this fact.

We were informed by AMC that Ford had made a written commitment to refund $5 million of profit realized on this subcontract. AMC expressed the opinion that—

> This refund will not only make up for the apparent error in negotiations but will also provide an Air Force sharing in the economies due entirely to Ford efficiency.

The explanations furnished by AMC for the large additional profit realized by Ford confirm our belief in the need for closer supervision by the Department of the Air Force of repricings of major subcontracts. The cited errors in cost projections submitted by the subcontractor and the weakness in negotiations appear to be deficiencies which should have been recognized and corrected in negotiations.

We do not suggest that the Air Force assume prime contractors' responsibilities for conducting repricing negotiations, but, since the Air Force does have a direct interest in the pricing of major subcontracts, such as Ford's $139,500,000 subcontract with Boeing, we believe that the Air Force should assure itself that the prime contractor fully protects the interests of the Government. Therefore, we have recommended that the Air Force more closely control price redeterminations between prime contractors and major subcontractors.

There is a second major point included in our report resulting from our audit that deals with the participation by the Government in voluntary price reductions by subcontractors.

We believe that significant voluntary price reductions given by subcontractors to prime contractors holding price redetermination contracts should be passed on to the Government. Operations under purchase order 952359 furnish, Mr. Chairman, an illustration of the need for clarification of the obligation of the contractor to the Government with respect to such price reductions.

In this case, Ford received more than $100,000 in the form of a voluntary price reduction made by a second-tier subcontractor. In May 1954, National Presto Industries, a subcontractor of Ford, informed Ford that they were reducing the price of flap tracks from $650.85 a unit to $615.50.

National Presto Industries made this voluntary reduction based on a survey which indicated that they would be able to supply the subject items at a lower cost to Ford for the immediate foreseeable future. They stated:

> It is our policy and desire to supply our Government with material needed for defense at the lowest possible price, consistent with quality production.

Ford acknowledged their appreciation of the reduction in cost and stated in a letter to National Presto Industries, dated June 24, 1954—

> It is our responsibility to obtain the ultimate value for each Air Force dollar spent, * * *.

At the time of our review, Ford had not offered to make any adjustment in the price of its subcontract with Boeing. We were unable to find any provision in Ford's contract with Boeing stipulating that adjustments in lower tier subcontract prices would also require adjustment of Ford's contract price.

In answer to our inquiry regarding this price reduction, Boeing stated:

> Since the subcontract between Ford and Boeing is a fixed-price type, it would appear inequitable to insist on a clause providing that Boeing and the Government would participate in any voluntary price reductions from Ford's lower

tier subcontracts in the absence of provisions for Boeing and the Government to similarly participate in cost overruns of this or any other element of cost which might be experienced by Ford.

This argument overlooks the fact that when Ford's major lower tier subcontracts were made, the subcontract between Ford and Boeing contained provisions for price redetermination, and thus Ford was not under any severe compulsion to negotiate close prices with its subcontractors. In any event, it seems reasonable that significant voluntary reductions in lower-tier subcontract prices should ultimately be recognized by adjustments in the prices under prime contracts.

In reply to our inquiry, the Ford Motor Co. indicated in a letter dated April 11, 1956, which is attached as appendix E to our report, that the voluntary price adjustment received from National Presto Industries had not yet been passed on to the Government.

However, the contractor pointed out that a proposed refund under consideration by Ford is based on the company's total cost experience under the B–47 program at Kansas City, including price adjustments by National Presto and other suppliers.

As previously mentioned, AMC has informed us that Ford has made a written commitment to refund $5 million. Therefore, in this instance, it appears that the Government will receive the benefit of the price reduction by National Presto.

However, dependence on voluntary refunds by the prime contractor as the means of effective equitable adjustments for voluntary price reductions received from subcontractors after a firm price is fixed for a redeterminable type supply does not, in our opinion, adequately protect the interests of the Government.

AMC rejected our suggestion that price redeterminable contracts and subcontracts might provide for participation by the Government in cost reductions resulting from significant voluntary price adjustments made by subcontractors. It was stated that such a provision, unless it also permitted sharing of cost increases, would be entirely unacceptable to contractors.

Their position is included in appendix F of our report.

The fact that in this case, both Ford and one of its subcontractors voluntarily offered refunds, because of reductions of costs below those contemplated, raises a question as to the validity of AMC's opinion as to the acceptability of such a form of contract. We believe that consideration should be given to means whereby the Government may be given the contractual right to share with prime contractors the savings which result from substantial voluntary price decreases offered by subcontractors after redetermined contract prices have been negotiated.

(The appendixes are as follows:)

APPENDIX A

TENTATIVE FINDINGS RELATING TO GENERAL ACCOUNTING OFFICE REVIEW OF PURCHASE ORDERS 952359 AND 952360 BETWEEN BOEING AIRPLANE CO. AND FORD MOTOR CO., KANSAS CITY REGIONAL OFFICE, OCTOBER 19, 1955

1. Purchase order 952359 issued by the Boeing Airplane Co. to Ford Motor Co. provided for a simultaneous retroactive and prospective redetermination of price when deliveries of 40 percent, but not more than 70 percent of the wing sets had been made. The purchase agreement also provided that the point of redetermination could be changed by mutual agreement. On April 1, 1952,

Boeing and Ford agreed that the redetermination point would be established at delivery of the 127th wing set, at which time a firm fixed price would be established for the remaining 327 wing sets.

The 127th wing set was completed in November 1953. Ford Motor Co. immediately requested the effective point of price redetermination be reestablished by mutual agreement as of January 31, 1954., when approximately 39 percent of the total wing sets would be completed. This extension was requested by Ford because of material alterations in the shipping schedules between April 1952 and November 1953, and because it would make additional cost experience available for consideration in establishing equitable redetermined prices.

Boeing declined to extend the effective point of redetermination, stating they were obligated to submit cost data to the Air Force by December 31, 1953, and start negotiations on the redetermination of their prime contract on February 1, 1954.

Subsequent events indicate Boeing could have and did negotiate with AMC prior to finalizing cost with Ford, using estimated figures furnished by Ford and voluntarily reducing their price to AMC after arriving at a fixed price with Ford. It is also noted that no subsequent redetermination was provided for even though there was not complete agreement between the contracting parties as to the most opportune point of price fixing.

It would appear that premature price redetermination and the absence of any provision for, or consideration to, subsequent redetermination, was the principal factor contributing to the Ford Motor Co. realizing profit, based on incurred costs, on the forward pricing of 327 wing sets, considerably in excess of that anticipated at the time of initial redetermination.

2. Boeing and Ford were unable to negotiate a fixed price on purchase order 952359 for the second pricing period (327 wing sets) prior to the time Boeing was obligated to negotiate a target price on their prime contract for incentive bonus with AMC. Boeing, however, submitted to, and was allowed by AMC, a target price for incentive bonus of $14,354,000 ($276,038 per wing set) to cover the cost of wing sets to be furnished by Ford. This price was based on estimates supplied by Ford. We noted that in September 1953 Boeing advised AMC that Ford should be able to produce B–47 wing sets at a cost of $199,000 plus 10 percent profit for a selling price of $218,900, and final prospective unit price finalizing between Boeing and Ford was $225,418.

Boeing in negotiating with AMC apparently provided a 26 percent markup based on their estimated cost $218,900, to cover contingencies in their estimates.

3. Durable tools were not retained by the Air Force under purchase order 952359. In the negotiation of costs for the first 127 wing sets there was an amount of $881,699 to cover the original complement of durable tools. Our review disclosed durable tools consisted of such items as:

Items	*Unit cost*
Wire spool racks	$646.15
Revolving bins	68.50
Hydraulic jacks	287.00
Layout tables	160.00
Drill press vises	192.00

Any repairs or replacements to their original complement would be proper charges to the supply contract. Thus, at contract completion, there would be a complete complement of serviceable durable tools.

A review of the minutes covering the price negotiations shows the contracting officer reviewed the list and stated they could qualify as facility items. (Ford had a separate cost reimbursable facilities contract.) However, with the contracting officer's approval, Boeing allowed these durable tool costs as a cost of the supply contract without addition of profit. It was agreed that, in lieu of profit, Ford would receive any residual value on disposal of these tools.

It should be noted that if the tools had been properly charged to the facilities contract, no profit factor would have been involved because the facilities contract was cost reimbursable and title to these tools would have rested in the Government at the time of acquisition.

It would appear that these items of durable tools were improperly charged to the supply contract and that appropriate action should be taken to assure that title of these tools revert to the Government.

4. Purchase order 952359 contained no provision for the Government benefiting from downward voluntary cost revisions made by subcontractors. We observed one instance, in our review at the Ford Motor Co., where the National

Presto Industries on May 15, 1954, reduced the unit cost of flap tracks from $650.95 to $615.50 under a covering letter stating:

"It is our policy and desire to supply our Government with material needed for defense at the lowest possible price, consistent with quality production."

The Ford Motor Co. acknowledged their appreciation of the reduction in cost, and stated in a letter dated June 24, 1954:

"It is our responsibility to obtain the ultimate value for each Air Force dollar spent * * *"

It was observed that this voluntary reduction in cost of flap tracks resulted in increased profits exceeding $100,000; however, the benefits in this instance accrued to Ford rather than to the Air Force or Government.

It would appear to be reasonable to provide in fixed-price type contracts provisions wherein the Government would participate in voluntary reductions of costs made by subcontractors.

5. The Boeing Airplane Co. entered into a fixed-price tooling contract (purchase order 952360) on July 9, 1951, with Ford Motor Co. for the procurement of special tooling required for the production of B–47 wing sets being procured under Boeing purchase order 952359.

Boeing was operating in the target area of a fixed-price contract, or effectively a cost-reimbursable contract, and, consequently, the price negotiated with Ford would have no financial effect on Boeing.

Article IB of the purchase order provided that as soon as the seller shall have "final firm prices from its vendors" or shall have incurred costs from fabricating and installing tools in 45 percent of the above-estimated prices, he shall submit to the buyer the proposed fixed price for the tooling covered by the order.

A fixed price will thereupon be established within 45 days or longer if agreed upon by negotiation. Ford Motor Co. subcontracted 73 percent of their contract on time and material or cost-plus-a-fixed-fee contracts and, consequently, would not have had "final firm prices from its vendors" until at least 73 percent of the contract had been completed.

At the date of final negotiation for a fixed price 98 percent of the final costs on the contract had been incurred or committed. However, Boeing negotiated a profit with Ford of 9 percent of incurred and estimated-to-complete costs. The negotiated profit figure allowed on incurred costs appeared to be high, inasmuch as 75 percent of the total incurred costs resulted from subcontracting by Ford, and also due to the fact that cost of administering and coordinating production of subcontractors was charged to the supply contract.

The above provision in the contract and the manner in which the contract was executed, in its effectiveness, appears to have created a cost-plus-a-percentage-of-cost contract.

APPENDIX B

From: Air Force plant representative, Boeing Airplane Co.

OKLAHOMA CITY AIR MATERIEL AREA,
GOVERNMENT AIRCRAFT PLANT NO. 13,
Wichita, Kans., November 10, 1955.

Subject: Review of Boeing purchase orders Nos. 952359 and 952360 issued by the Boeing Airplane Co. to Ford Motor Co., Kansas City, Mo., on the B–47 wing procurement.

To: Government Accounting Office, Kansas City Regional Audit Office, Attention Mr. Forrest R. Browne, Regional Audit Manager, Room 2512, Federal Office Building, Kansas City, Mo.

1. Reference your letter dated October 19, 1955, the above subject. Copies were transmitted to Boeing, and attached herewith are the comments of the Boeing Airplane Co., letter 9100–0–364, dated November 3, 1955, above subject.

2. As you were previously advised by the undersigned at various times during the past year, the subject matter has been coordinated with Headquarters, AMC; likewise, the contractor's comments were discussed at AMC November 7 through 9, 1955.

3. During the above discussion it was learned that AMC was negotiating with Ford relative to a voluntary refund by Ford on the subject purchase orders, and that a substantial refund by Ford to Boeing would be made in the very near future. This refund will not be subject to incentive participation by

Boeing, as agreed to in the final price redetermination negotiations under contract AF 33(600)-5158 in November 1955 at AMC. You will be advised when the above refund is made to Boeing.

GEORGE E. NEWTON,
United States Air Force Contracting Officer.

BOEING AIRPLANE CO.,
Wichita, Kans., November 3, 1955.

To: General Accounting Office, Kansas City Regional Audit Office, Kansas City, Mo.
Attention: Forrest R. Browne, regional audit manager.
Through: AF plant representative (OCRWC).
Subject: Review of Boeing purchase orders Nos. 952359 and 952360 issued by Boeing to Ford Motor Co.
Reference: (*a*) GAO letter, Forrest R. Browne to George T. Newton, dated October 19, 1955, same subject; (*b*) OCRWC letter to Boeing, dated October 20, 1955, same subject.

1. Following are contractor's comments concerning the tentative findings of the General Accounting Office relating to their recent review of purchase orders Nos. 952359 and 952360 issued by Boeing Airplane Co. to Ford Motor Co. Each of the following comments is related to the specific paragraph of the GAO tentative findings.

2. Paragraph 1, subparagraph 3. At the time Ford's letter of November 21, 1953, requesting an extension of the price redetermination date was received, which in itself references earlier discussions on this subject, it was considered by Boeing to be another attempt on the part of Ford to extend the experience period, thereby allowing more cost to be recorded prior to the negotiation date, which would reduce the risk area in the prospective pricing period. The dynamic nature of airplane manufacturing is such that reasons for changes in price-revision dates can almost always be found if a subcontractor desires to request a change. Such a delay, however, would have been contrary to the true concept of the Department of Defense type IIB price-redetermination subcontract. Regarding this type of contracting, Department of Defense directives suggest that price redetermination be accomplished at a point approximating 25 percent of the deliveries. It has been Boeing-Wichita's consistent policy to establish price-redetermination points varying from 20 to 33 percent of scheduled deliveries. It is to be noted that the point of price redetermination agreed to and established with Ford, unit 127 represented 28 percent of the deliveries. Had an extension been granted Ford, as they requested, over 60 percent of the total units would have been delivered and substantially all costs would have been either recorded or known at the time of negotiation. That situation would not have been considered consistent with the purpose of the price-redetermination-type subcontract.

3. Paragraph 1, subparagraph 4. The establishment of the date for the incentive target-price negotiation of the Boeing prime contract was made with the full knowledge that the price-redetermination negotiations with Ford would not be completed in time for the negotiated price to be available. Notwithstanding, it was considered essential to time the negotiation with Ford so that data in support of the pending subcontract negotiation could be used as a basis for Boeing's prime-contract negotiation. Boeing did use the pricing data submitted by Ford for the Boeing price-revision activity, later voluntarily revising the prime-contract price to reflect the negotiations with Ford.

4. Paragraph 1, subparagraph 5. Price-redetermination negotiations with Ford were conduted at a time when deliveries were 42 percent complete. It is Boeing's position that should a price-revision activity with a subcontractor occur at a time when the percentage of completion is substantially higher than 42 percent, the result would be equivalent to after-the-fact price redetermination. Likewise, a subsequent redetermination, based on a quantity of additional units, would have resulted in a second redetermination at a time when essentially all costs of the remaining 327 units would have been known. After-the-fact price redetermination of a type II–B subcontract is not permissible under Department of Defense prime contracts.

5. Paragraph 2. It was never intended that the negotiated price with Ford would be available prior to the time Boeing was obligated to negotiate its prime contract. The amount used by Boeing for its prime contract negotiation was the exact amount of Ford's fixed price proposal for price redetermination pur-

poses. The $199,000 cost figure mentioned by GAO which, with profit, computed into an estimated selling price of $218,900, was an exercise prepared by Boeing, in which Boeing attempted to estimate the optimum price that could be expected at Ford. This figure was developed only for use in a letter to AMC which requested that Boeing be allowed to produce wings being subcontracted to Ford and which pointed out the estimated cost savings to the Government if such permission was granted.

The optimum price for Ford was employed to avoid any possibility of overstating the savings that would accrue from this change. The number prepared for this exercise were purely for the purpose of this specific request and were never intended as a basis for contract negotiation. The Air Force subsequently determined to maintain its subcontracting broad base and continued with the Ford operation in keeping with this philosophy. Any comparison of the aforementioned exercise with the amount negotiated with Ford is entirely irrelevant, and the assumption concerning the 26 percent markup is, therefore, obviously unfounded. Further, as previously mentioned, Boeing voluntarily revised the prime contract price, both cost and profit, downward to reflect the exact price finally negotiated with Ford. This substantiates the fact that Boeing was attempting to include in its prime contract price only the amount that Boeing would have to pay Ford.

6. Paragraph 3. Ford stated that a portion of the items classified as "durable tools" had been submitted by Ford to their contracting officer with a request that they be purchased under Ford's facility contract. Ford further stated that the contracting officer had refused this action under that contract. Since the remaining items under question were of a similar nature, Ford proceeded to charge them to the supply contract under the assumption that a precedent had been established, and that since the items had been refused under the facility contract, their cost would be allowable under the supply contract. During the interim, however, a different contracting officer was assigned to the Ford facility. Based on his examination of the list of items in question at the time of the price redetermination negotiations, the contracting officer stated that he would have approved a majority of the items on the facility contract if they had been submitted to him. In an effort to arrive at an equitable settlement, he suggested that the cost in question be allowed on the supply contract wtihout profit. Ford objected strenuously to this proposal on the basis that since the items in question were not recognized by the Air Force as facilities that they must be supply contract items and, as such, subject to profit allowance. Boeing insisted on withholding the profit as a penalty to Ford for not having submitted all of the items to the contracting officer for procurement as facilities. The Air Force representation at the negotiations was amenable to this action, and Ford finally agreed to the Boeing proposal in the interest of negotiation. It is questionable that substantial value would accrue to the Government merely by acquisition of title to these items.

7. Paragraph 4. Since the subcontract between Ford and Boeing is a fixed price type, it would appear inequitable to insist on a clause providing that Boeing and the Government would participate in any voluntary price reductions from Ford's lower-tier subcontractors in the absence of provisions for Boeing and the Government to similarly participate in cost overruns in this or any other element of cost which might be experienced by Ford.

8. Paragraph 5. Ford's original fixed price proposal, dated October 19, 1952, was based on costs incurred through August 31, 1952. Recorded costs were stated to be $6,978,000, as compared with estimated costs at completion of $19,100,000, or 36.5 percent complete. During the course of the audit of Ford's submitted cost statement, the Air Force resident auditor at Ford's facility at Kansas City requested the cognizant Army Audit Agency in Dearborn, Mich., to perform an audit of the costs incurred at the subcontractor's Dearborn tool and die division. The Air Force Audit report of Kansas City costs was received by the contractor on December 30, 1952, and the Army Audit Agency report of costs incurred at Dearborn was received April 2, 1953. In the interim the subcontractor submitted a revised statement of cost and proposed fixed price based on costs incurred through February 28, 1953, which reflected a change in purchase order requirements from a lot of tools capable of producing 1,500 B–47 wing sets at a maximum rate of 66 sets a month, to a lot of tools capable of producing 1,500 B–47 wing sets at a maximum rate of 50 sets a month. Although the revised proposal reflected incurred costs representing 91.4 percent of total estimated costs at completion, this high percentage of completion was, to a considerable extent, the result of the reduced tooling work statement which was incorporated in the revised proposal.

Profit was allowed in the negotiated fixed price at 9 percent of total incurred costs, less intracompany billings. No profit was allowed on intracompany billings since it was determined that profit was included in the billings from the first division to the second. On the remaining negotiated costs, Boeing proposed that 6 percent of cost would represent a reasonable profit allowance, considering the reduced risk resulting from the high percentage of completion at the time of the negotiation, April 22, 1953. Ford had requested 10 percent of cost as a profit allowance. Giving consideration to the following points, Boeing and Ford agreed to 9 percent of cost, exclusive of the intracompany items:

(*a*) A substantial portion of reductions offered by Ford subsequent to the original price proposal, and prior to the negotiation, was attained through improved efficiency of tool planning, tool fabrication, and outside tool procurement. These reductions were accomplished by Ford in full knowledge that profit would be computed on negotiated costs. The resultant dollar amount of profit was, therefore, much less than originally anticipated by Ford at the inception of the program.

(*b*) Any attempt to minimize profit further at the negotiation would be a penalty resulting from a lapse of time required to obtain Air Force audits and which was no fault of Ford. (The records also show that this was no fault of Boeing's since repeated requests were made through the local Air Force resident auditor's office to expedite completion of the reports.) The point being that, in good faith, Ford submitted a proposed fixed price on October 19, 1952, and that as a result of delays in accomplishing the audits the price negotiations were unduly delayed.

BOEING AIRPLANE CO., WICHITA DIVISION,
CARL E. DILLON,
Divisional Director of Finance.

APPENDIX C

BOEING AIRPLANE CO.,
Wichita, Kans., December 1, 1953.

Subject: Price Redetermination.
Reference: Ford letter, Holden to Henricks, dated November 21, 1953.

FORD DIVISION OF FORD MOTOR CO.
KANSAS CITY AIRCRAFT PLANT,
Kansas City, Mo.

(Attention: Mr. T. H. Holden, Executive Assistant, Kansas City Aircraft Plant.)

GENTLEMEN: The reference letter requests a change in the point established for price redetermination of the B–47 wing program. Due consideration has been given to the proposal, however, based on contractual requirements under Boeing's prime contract, it is mandatory that the provisions for price redetermination as presently provided for be complied with, i. e., that your statements of cost and proposed fixed prices for the quantities subject to this redetermination be submitted within 45 days after completion and delivery of the 127th article.

Boeing is obligated, under provisions of its prime contract AF33 (600) 5148, to submit cost data to the Air Force by December 29, 1953, to be used as a basis for negotiating prices for B–47 airplanes ordered thereunder. Tentatively, the time established for our prime price negotiation has been set for early February 1954, therefore, it is imperative that we have your statements of cost and proposed fixed prices on schedules in accordance with the present agreement.

We are of the opinion that sufficient cost experience will have been recorded at the time the 127th article is delivered to serve as a basis for projecting equitable prices that will be acceptable to both Boeing and Ford.

Very truly yours,

BOEING AIRPLANE CO., WICHITA DIVISION,
DURWOOD HENRICKS,
Buyer Supervisor, Outside Production.

APPENDIX D

NOVEMBER 21, 1953.

BOEING AIRPLANE CO.,
WICHITA DIVISION,
Wichita, Kans.

(Attention: Mr. Durwood L. Henricks, supervisor, outside production.)

GENTLEMEN: This letter acknowledges receipt of yours of November 18 concerning overtime approval for the Ford Motor Co., October 24, 1953, through January 31, 1954.

Reference is also made in this letter to discussions concerning the revision of the point at which redetermination of wing prices will take place. We appreciate your position but wish to submit the following for your further consideration.

In the meeting held at Wichita on April 1, 1952, attended by representatives of Boeing and Ford, it was agreed, with regard to the fixing of wing pricing periods, that the first pricing period be established at the delivery of the 127th wing set. However, in reaching this agreement, it was our understanding that consideration would be given to altering the end of the first pricing period should the total number of wing sets be increased or decreased, or should there be any significant change in the shipping schedule.

The composite sequence shipping schedule, No. 11–R–8, dated October 8, 1953, provides for a reduction in the production rate of wing sets per month and thus extends delivery over a considerably longer period of time. This has caused us to reanalyze the advisability of retaining the 127th wing set point for redetermination, and as discussed with you recently, it is our feeling that consideration should be given to reestablishing the point of redetermination at January 31, 1954, at which time approximately 39 percent of the total wing sets on order under the basic purchase order will be delivered, based on the current composite sequence shipping schedule referred to above.

Our proposal is primarily based on the following two considerations:

1. The shipping schedule in effect at the time the above agreement was reached provided for delivery over an 18-month period. The 127th wing set was to be delivered during the 10th month, thereby fixing the duration of the second-pricing period at 8 months. The current shipping schedule requires delivery of the same total of wing sets over a 24-month, rather than an 18-month period. This schedule contemplates that delivery of the 127th wing set will be completed during the 11th month, but extends the duration of the second pricing period, by 5 months, to 13 months.

The extension of this period, during which a fixed price will apply, will increase the possibility of variance from the forecasted cost-price relationship. This situation would be somewhat alleviated by redesignating the end of the first pricing period at January 31, 1954, as proposed, and thereby reducing the second-pricing period to 11 months.

2. This revision would be of mutual benefit, since it would make additional cost experience available for consideration in the establishment of equitable redetermined prices.

In view of the above, we request that the effective point of price redetermination be reestablished by mutual agreement at January 31, 1954, when approximately 39 percent of the total wing sets on order under Boeing's purchase order 952359, Lockheed purchase order J2–00001, and Douglas Purchase order OMID–9005 are delivered.

We hope that full consideration will be given to this request. We will be pleased to discuss it with you at your earliest convenience.

Yours truly,

THOMAS H. HOLDEN.
Executive Assistant, Kansas City Aircraft Plant.

APPPENDIX E

FORD DIVISION OF FORD MOTOR CO.,
KANSAS CITY AIRCRAFT PLANT,
Kansas City, Mo., April 11, 1956.

Subject: B–47 wing program; Boeing purchase orders 952359 and 952360.

Mr. FORREST R. BROWNE,
Regional Audit Manager, United States General Accounting Office,
Regional Audit Office, Federal Office Building, Kansas City, Mo.

DEAR SIR: In response to your letter of March 30, we wish to advise that the proposed refund under consideration by the Ford Motor Co. is based upon our total cost experience under the B–47 program at Kansas City, and, hence, includes any voluntary adjustments from suppliers including that received from National Presto Industries.

We appreciate the opportunity to review your tentative findings, and while we believe the factual statements made therein are generally accurate, we cannot concur in certain of your conclusions drawn therefrom. While your suggestions concerning durable tooling have considerable merit, we believe a stronger justification can be made for continuing contractor ownership of such tooling under fixed-price contractual relationship.

We trust that the time involved in the preparation of our reply to your communication has not delayed you in the submission of the final report of your investigations of our activities here at Kansas City.

Very truly yours,

M. R. SCHERMERHORN, Jr., *Controller.*

APPENDIX F

OFFICE OF THE COMMANDER,
HEADQUARTERS, AIR MATERIEL COMMAND,
Wright-Patterson Air Force Base, Ohio, July 17, 1956.

UNITED STATES GENERAL ACCOUNTING OFFICE,
Washington, D. C.
(Attention Mr. Ben H. Puckett, Assistant Director.)

DEAR MR. PUCKETT: We acknowledge receipt of your letter of June 13, enclosing a preliminary draft of a report on certain aspects of operations of Ford Motor Co., Kansas City, Mo., subcontractor under Department of the Air Force prime contract with Boeing Airplane Co., Wichita, Kans. You requested an expression of our views on the draft of this report.

The report deals with three aspects of the administration of the Boeing subcontract with Ford: (*a*) The high rate of profit realized by Ford on the runout portion of the contract subsequent to price redetermination; (*b*) the retention of title by Ford to durable tools for which Ford had been reimbursed under the supply contract; and (*c*) nonparticipation by the Government in voluntary price reductions by subcontractors. Comments of this command are as follows:

PROFIT REALIZED BY FORD SUBSEQUENT TO PRICE REDETERMINATION

The GAO invites attention to a profit rate of 28.9 percent realized by Ford in the prospective portion of the repriced contract, as compared with the profit rate of 10 percent contemplated in the redetermination, and suggests that "Ford realized profits substantially higher than those contemplated in negotiation chiefly because redetermination was made before sufficient production experience and related costs had been obtained."

It is the policy of the Air Force, and of the Department of Defense, to negotiate prospective prices, and to establish firm, fixed prices at the earliest practicable date. Firm, prospective prices do not of themselves create profits. The contractor can realize profit only to the extent that he holds costs below the established price.

The redetermination of the Ford subcontract was conducted in March of 1954, at which time 190 wing sets (42 percent of total of 454 then on schedule) had been completed. Cost statements were submitted covering production experience through completion of the 127th set (28 percent of toal on schedule). Review of the report of negotiation does not indicate any failure to give consideration to all the available data, nor does it disclose any suggestion on the part of the negotiators that the available information was insufficient for establishing firm, fixed prices. While they did not participate in the negotiations, nor did they assume the responsibility of the prime contractor for accomplishing redetermination, Air Force representatives were present as observers and did participate as advisers to Boeing during the negotiations.

An independent inquiry conducted by Headquarters AMC in October of 1955 resulted in conclusions as follows:

(1) The timing of the repricing negotiations was not premature, but was conducted at the earliest practicable date in accordance with Air Force and Department of Defense policy.

(2) Cost projections by Ford, especially with respect to cost of materials and subcontract items, were not realistic. It is recognized that Ford was pursuing a continuing program of cost reductions in acquisition of materials. Under normal lead-time practice, however, the commitments for purchased items would have been substantially completed at the time of contract repricing, and cost reductions should have been sufficiently firm to be reflected in forecasts of cost of completion of the contract.

(3) Negotiators, in evaluating projections of labor costs, did not give adequate recognition to the downward trend of total labor hours required per wing set. The cumulative learner's curve of 80 percent used in negotiation (amounting to an 88 percent curve on the prospective portion) is not ordinarily considered a proper curve application from an unusually high starting point or from a portion of a project which has been showing a level curve. Application of an 80 percent curve to the wing sets to be produced subsequent to the time of repricing would show an average of 12,500 hours per set which would have been more appropriate than the 15,760 hours negotiated.

(4) The cost savings effected by Ford in the prospective portion of the contract period were substantially greater than reasonably could have been anticipated even had there been (*a*) full recognition of savings which then could have been anticipated, based on firm purchase commitments; and (*b*) projection of labor hours from the 190th set on an acceptable 80 percent learner's curve. It must be recognized that Ford, in attaining approximately a 60 percent curve from the 190th set, performed an outstanding job in relation to normal expectations.

While we must recognize, in an after-the-fact analysis, that the negotiations did not reflect the optimum use of all the pertinent data then available, it does not follow that the negotiations were conducted prematurely, or that the Air Force should have assumed the prime contractor's responsibility in conducting the negotiations.

There is no accurate measure of the extent to which the profit realized by Ford can be attributed to the incentive resulting from the early firming of contract prices, but this incentive factor must be recognized, and the results achieved add support to the Air Force procurement policy of maximum use of the incentive approach in selection of type of contract, establishing pricing formulas, and administration of special pricing articles. The Air Force has benefited from the economies effected by Ford through lower prices on follow-on production of wing sets. In addition, Ford had made written commitment to refund to the Air Force, through the prime contractors, $5 million of profit realized under purchase order 952359. In our opinion this refund will not only make up for the apparent error in negotiation but will also provide an Air Force sharing in the economies due entirely to Ford efficiency.

RETENTION OF TITLE TO DURABLE TOOLS BY FORD

We concur with your recommendation that procurement contracts which include reimbursement to contractors for special tooling provide that title to tools so acquired vests in the Government or that contract prices reflect credit to the Government for the residual value of such tools. This is consistent with the policy directives of section XIII of ASPR and of AFPI.

It appears that Boeing, in this instance, used a procedure not necessarily contradictory to Air Force policy. Prior to the negotiation, the Boeing nego-

tiators obtained from Air Force personnel an estimate of the probable residual value of the durable tools. They were informed that the only residual value would be scrap value or something less than 10 percent of cost. It was further stated that a large portion of this return would be consumed in listing, advertising and disposing the inventory. In subsequent negotiations, Boeing was successful in negotiating a price without profit except that the title to the durable tools would remain in Ford. In our opinion, in view of the nominal residual value involved, this appears to have been a satisfactory deal.

NONPARTICIPATION BY THE GOVERNMENT IN VOLUNTARY PRICE REDUCTIONS BY SUBCONTRACTORS

It is agreed that it would be very desirable, from the Government's standpoint, to participate in all price reductions, and in all cost savings. In cost reimbursement type contracts that is accomplished. Of course, in that type of contracting, the Government must also bear the burden of increases in cost. Fixed-price contracts contemplate the risk to the contractor of fluctuations in costs. A requirement that the contractor pass on to the Government any savings, but bear any increases in cost, would make such form of contract entirely unacceptable to the contractor.

We appreciate this opportunity of expressing our views on the draft of the GAO report.

Sincerely yours,

E. W. RAWLINGS,
General, USAF, Commander.

Mr. POWERS. In summary, Mr. Chairman, our review disclosed that Air Force supervision in this case was too limited considering the $139 million involved in the subcontract. We believe that under large subcontracts the prime contractor's negotiations should be closely supervised, particularly where the contractor does not have a financial incentive to negotiate the lowest possible price and, even more important, when he stands to benefit from a higher price, as in this case.

We have suggested to the Air Force that instructions or regulations be established to require special measures and safeguards over the pricing of the larger subcontracts.

We have also suggested that the Air Force reconsider the advisability of insisting that a price be finalized where there is insufficient cost data. It seems apparent that this practice results in the supplier including in his bid very substantial allowances for contingencies, probably without identification.

The circumstances in this case indicate that either (1) the Air Force was unaware of the subcontractor's concern about the reliability of the cost data; or (2) it did not recognize the importance of this matter and thus did not insist on delaying the redetermination or providing for subsequent adjustment in the subcontract price and prime target. Failure to utilize one of these safeguards seems to constitute an unnecessary risk of Government funds with greater prospect of loss than gain

We would be glad, Mr. Chairman, to answer any questions that the committee may have concerning our review and to explain our report.

Mr. HÉBERT. Let me make this comment on behalf of the committee, to thank you for the very comprehensive statement which you have made, and to say that you do echo the feelings of this committee, I am sure, in the summary which you have presented.

And also to thank you and your associates in the General Accounting Office, which of course is the arm of the Congress, for its cooperation in this particular field of negotiation.

As you undoubtedly know, this committee last year, or 2 years ago rather, held a long conference with representatives of the General

Accounting Office in an effort to establish a more cohesive cooperation between the General Accounting Office and this committee, which is interested in the same area of procurement for the Government.

And it is my belief—and I am sure it is the belief of the committee—that this type of presentation and this type of cooperation is what we need to accomplish the goal which is our objective—economy in Government.

And I feel that this case is just merely one of many which we will be able to uncover as this hearing progresses.

Mr. Courtney.

Mr. COURTNEY. Mr. Chairman, so that we may bring the matter right down to focus, the General Accounting Office brought the subject matter of this report to the Department of the Air Force by letter of transmittal. I think it might be pertinent to your consideration today to have the response which was made.

You will find a carbon copy of the letter on your desk, dated January 18, 1957, to Mr. William A. Newman, Deputy Director, Defense Accounting and Auditing Division, GAO, signed by Max Golden, Deputy Director for Procurement and Production, Department of the Air Force.

Mr. Newman, would you like to discuss that—or Mr. Powers?

Mr. NEWMAN. This letter is from the Department of Air Force, signed by Mr. Max Golden, Deputy for Procurement and Production, and is dated January 18, 1957:

> The letter of July 17, 1956, of Gen. E. W. Rawlings, Commander, Air Materiel Command, reflects, in general, the Air Force views on your report, in respect to (*a*) the high rate of profit realized by Ford on the runout portion of the contract subsequent to price redetermination, (*b*) the retention of title by Ford to durable tools for which Ford had been reimbursed under its supply contract, and (*c*) nonparticipation by the Government in voluntary price reductions by subcontractors.
>
> With respect to the high rate of profit realized by Ford, admittedly the prime contractor's price negotiations with the subcontractor left much to be desired, as explained in General Rawlings' letter of July 17. However, a refund has been obtained from Ford in the amount of $5 million in connection with purchase order 952359, which compensates in great part for the apparent error in negotiations and, in addition, accords to the Air Force a share in the economies resulting from Ford's efficient operations. While we do not believe that Ford's approach to negotiation in this case represents a pattern with respect to its pricing practices, our procuring people have been alerted to the high rate of profit realized by Ford in this case in order to avoid a recurrence.
>
> With respect to the statement in your report that redetermination of the subcontract price was premature from the standpoint of production experience, the Department of Defense policy is that firm fixed prices should be established at the earliest practicable date. This is also Air Force policy and practice and is inherent in the fixed-price method of contracting. It is also consistent with the past views of your office on a related problem, early definitization of letter contracts, that we must avoid pricing after-the-fact, or after the major portion of the contract has been completed.
>
> In the past the Air Force has recognized a need for supervision over the pricing and repricing of major subcontracts. In fact, it has been alleged from time to time by industry that the Air Force, in contrast to other Government agencies, overcontrols its prime contractors in connection with such subcontracts. The problem is one of striking the proper balance between insuring by appropriate supervision by the Air Force that proper subcontract pricing is being accomplished by the prime, but avoiding at the same time interference with the prime's managerial abilities and prerogatives in performing the contract, for which we have hired him and are paying him a profit. We believe we have made much progress in this area in the past few years.

Mr. NEWMAN. The next paragraph in the reply from the Air Force deals with durable tools. Mr. Powers hasn't read it but is in our report as the second recommendation.

Mr. HESS. Wouldn't it be well, Mr. Chairman, to have the complete letter read in at this point?

Mr. COURTNEY. Mr. Hess, the General Accounting Office has presented its views with respect to title and durable tools. It does not deal with the question of redetermination and renegotiation of contracts, and therefore, it was not detailed in Mr. Powers' presentation.

So, the next paragraph in the letter deals with that subject, which has not heretofore been touched on. The letter in whole will be placed in the record.

Mr. COURTNEY. It deals only with durable tools and doesn't deal with the subject under inquiry. It would be more of the same, I might add.

(The portion of the letter not read is as follows:)

With respect to the treatment of durable tools under purchase order 952359, we would agree, as did AMC, with the statement made in your report, that the Government should receive the full benefit of tools purchased with Government funds and that procurement contracts should also provide that title to tools so acquired vests in the Government of that the contract prices reflect credit to the Government for the residual value of such tooling.

AMC's explanation is that the residual value of the tooling was considered in the arrangement made with Ford and that the factors of no-profit acquisition of the tooling and the elimination of the cost of disposition offset any such residual value.

We are informed that the property in question falls in the main within the category of special tooling. Settlements of this type depend entirely on the facts of the particular case including the nature of the tooling to be acquired, the prospective use, and the ultimate cost of disposition. We question the desirability, as a matter of policy, of prescribing inflexible rules in such matters, particularly in the subcontract area. In the final analysis, such settlements are part of the negotiation process and we must rely on the competence of the personnel representing the Government in the negotiation. We doubt that the answer is to be found in any particular formula or procedure.

Mr. HÉBERT. All right, Mr. Newman.

Mr. NEWMAN (reading):

The reasons for nonparticipation in voluntary refunds by subcontractors on a contractual basis are set forth in General Rawlings' letter. We believe any attempt to participate in such voluntary refunds as a matter of contract right would be countered by contractor insistence that the Air Force also participate in unanticipated cost increases. It is felt that the best way to cope with this problem is through effective contract pricing, vigilant administration, and the proper selection of types of contracts, rather than through a contractual procedure which may compromise the basic concept of fixed-price contracting.

We believe, therefore, that the solution to the matters discussed in your report is to be found in the improvement of contract procedures, pricing, and administration, including surveillance of major subcontracting. We share your concern that the need for improvement in procedures should be a matter of primary consideration. This is a continuing program in the Air Force. Subsequent to the subcontract repricing of Boeing Purchase Order 952359, the Air Materiel Command issued Air Materiel Command Manual 70–3, Manual for Analysis of Contract Procurement (copy inclosed), for the guidance of Air Force personnel in evaluating the procurement practices of Air Force contractors, and for maintaining surveillance over Air Force contractors' purchasing operations. This manual supplements Air Force Procurement Instructions (Sec. LIV: Contract Administration, Pt. 2), revised as of October 19, 1956, a copy of which is attached. In addition, and in order to effectively apply the procedures affecting major subcontracting by Air Force contractors, Air Materiel Command has instituted a program to intensify training of personnel through the medium of schools, training films, seminars, and conferences supplemented by on-the-job training.

We feel that your report has been most helpful in pointing up those areas which require most careful attention and review to insure effective contract pricing and administration.

We appreciate this opportunity of expressing our views on the GAO report.

Sincerely,

MAX GOLDEN,
Deputy for Procurement and Production.

Mr. COURTNEY. Mr. Chairman, the conclusions which were read by Mr. Powers appear in the letter of February 8, 1957.

Mr. POWERS. That is correct.

Mr. COURTNEY. Which has been quoted in full. I would like to ask one question as a matter of accounting, Mr. Powers, or Mr. Newman or any of your gentlemen that would care to answer it.

Do you have any information as to why a question in respect to subcontracts in connection with the B–52 contract in question would not identify a purchase order of this kind, amounting to $139 million?

As accountants, could you—would you expect to find it on a report of the cost of producing the B–52 under this contract?

Mr. POWERS. I believe you mean the B–47?

Mr. COURTNEY. The B–47, I am sorry. Yes.

Mr. POWERS. It would seem to us in the absence of any other factors that may have been present that this transaction should have been identified for the committee in answering its specific request.

Mr. COURTNEY. Well, do you find any distinction in law or in fact between the subcontract and the purchase order of this character?

Mr. POWERS. No, sir.

Mr. NEWMAN. We make no distinction.

Mr. COURTNEY. Mr. Chairman, I would like to call attention to the subcommittee that in reporting—and remember in this case the subcommittee accepted the statements that were made as voluntary and true—that in reporting on this particular contract, of which this $139 million purchase order was a part, the subcontracts over $100,000 are presumably itemized on page 1899. There is no mention of the Ford Motor Co., or $139 million.

Mr. HESS. This is Boeing's questionnaire?

Mr. COURTNEY. Yes, sir.

Mr. POWERS. Mr. Courtney, could I interrupt there for clarification?

Mr. COURTNEY. Yes, sir.

Mr. POWERS. Boeing in this transaction was performing as a technical prime contractor for the delivery of the 454-wing assemblies that were sent to Boeing, Douglas, and Lockheed.

Now, under its own contract Boeing obtained from Ford only 57 of the wing sets. Douglas received 172 of the wing sets. And Lockheed received 225. Boeing, therefore, would be required to pay Ford——

Mr. COURTNEY. For 57?

Mr. POWERS. For 57, instead of the total 454.

Mr. COURTNEY. Which would amount to more than $100,000, would it not?

Mr. POWERS. That would approximate $15 million.

Mr. HESS. Let me ask you, Mr. Courtney: Have Douglas and Lockheed—they were the other two? Have they in their questionnaires reported this subcontract with Ford?

Mr. COURTNEY. They report on the Boeing subcontract?

Mr. HESS. Do I understand there was a subcontract from Boeing to Douglas and Lockheed?

Mr. POWERS. No, sir.

Mr. HESS. Or are they all three prime contractors?

Mr. POWERS. They are all three primes, sir.

Mr. HESS. Then, the subcontracts of all three were with Ford?

Mr. POWERS. That is right, sir.

Mr. HESS. That is what I was asking you, Mr. Courtney—if Douglas and Lockheed have reported in their questionnaire the subcontracts they had with Ford.

Mr. COURTNEY. The specific question, if you remember, was asked with respect to $100,000 contracts and in excess thereof. This contract had to be, so far as Boeing was concerned, in excess of $15 million, on the statements that have been made here this morning and the admissions that have been made in the correspondence.

The only place that that item can appear in the report that was made to this subcommittee, in March of 1956, and publicly reported, was under production, material and purchased equipment, which is an item of $165,520,751, on the B–47 contract, by name, number, page, and date.

Mr. BATES. What is the answer to your question?

Mr. HESS. Now, the other companies, Douglas and Lockheed Cos., were they directly responsible to the subcontractor for payment?

Mr. COURTNEY. Boeing was the purchasing agent for them, as Mr. Powers explained.

Mr. POWERS. It is our understanding, Mr. Chairman, that the relationship between Douglas and Lockheed and Ford was, that while Boeing retained technical responsibility over the $139 million transaction, the financial relationships of these two other aircraft companies with Ford was a direct one, and that they paid Ford directly for that portion of the wing sets delivered to their respective companies.

Mr. HÉBERT. On the basis of the figure arrived at by Boeing?

Mr. POWERS. Boeing, yes, sir. In other words, the other two companies were bound to pay the same price that was negotiated by Boeing as a technical prime contractor.

Mr. HESS. I understand that. They were to pay the same price as Boeing was paying.

Mr. POWERS. Right, sir.

Mr. HESS. All three paying the same price.

Mr. POWERS. Right, sir.

Mr. HESS. But what I am trying to find out here, now—here we are complaining because Boeing did not return this information in their questionnaire?

Mr. COURTNEY. That is correct.

Mr. HESS. Now, did Douglas and Lockheed return it in their questionnaire?

Mr. COURTNEY. In other words, if this committee wanted to find this contract from Boeing's report to us, after having asked the question with respect to subcontracts, it could not find it.

Mr. HESS. All right.

Could it find it with Lockheed or Douglas?

Mr. FOGO. Mr. Hess, may I interrupt there?

We did not know about these other two companies prior to this testimony.

Mr. HESS. Oh, I see.

Mr. FOGO. So we have had no opportunity to check the record on whether they are in there. We did check the record on Boeing prior to coming into the hearing.

Mr. HESS. All right. I think we better check the record to see whether Douglas and Lockheed are in the same position.

Mr. FOGO. Yes, sir, we would have to check the record to give an answer to the question you raised.

Mr. COURTNEY. Up to this point, we are not able to find it, but we definitely were not able to find it in the Boeing case.

Mr. HÉBERT. But we are interested in discussing the matter to this conclusion, to capsule it up, that Boeing showed no interest in recovering this $5 million from Ford, nor did the Air Force show any interest in recovering the $5 million from Ford, which could voluntarily—not voluntarily, but insisted upon giving back to the Government the $5 million, which of course was taxpayers' money—Government money.

Is that a correct conclusion?

(Mr. Powers confers.)

Mr. POWERS. We found no evidence, Mr. Chairman, that Air Force or Boeing had endeavored to obtain the refund from Ford. The only evidence we had or obtained from the Air Force (see appendixes E and F) was that Ford had given them a written commitment to refund the $5 million.

Mr. HÉBERT. And then Ford, in turn, for its insistence upon returning to the Government this $5 million excess profit. the Air Force then alerted its inspectors to look out for future violations whereby more money could be returned from Ford?

Mr. POWERS. That is right, sir.

Mr. HÉBERT. That is in effect. So Ford comes in and says, "Government, here is $5 million. I want to give it to you, or we want to be fair with you, and so does the other company."

And the Air Force turns around and says "We will take the money now that you are insisting on giving to us, but we are going to tell our inspectors, 'Be careful you might be doing it again,' because you are too good."

That is in effect what happened?

Mr. NEWMAN. Pretty much.

Mr. HESS. Plus the further point, Mr. Chairman, they made no further effort to recover $4,800,000 in addition which was overpayment, but says "Well, Ford has been very kind, they have given us $5 million back, we have gotten a portion of it back, we will make no effort to go after the rest."

Fine representation for the taxpayers.

Mr. HÉBERT. And commenting on the letter from the Department, I must say it is another example of superb gobbledegook and guff and a lot of words, and I just wonder how many man-hours they have taken up to write these kinds of things, a lot of pretty words, that "We are going to issue new instructions but the practice will continue."

Mr. MILLER. Mr. Chairman.

Mr. HÉBERT. Mr. Miller.

Mr. MILLER. Mr. Chairman, does the $5 million refund apply against the whole $139 million?

Mr. COURTNEY. Yes.

Mr. MILLER. Or just that portion of Boeing's contract as the technical, I believe you said, prime contractor? Which again, to me, seems to be a lot of superfluous wording someplace.

But what did Lockheed and Douglas do? Did they just accept Boeing's negotiations on this thing without going into it to see whether they could make a better deal?

Mr. POWERS. They had, Mr. Miller, no responsibility other than what had been assigned to Boeing. In other words, the total refund of $5 million, we understand, would be made against the total $139 million purchase order issued to Ford.

Mr. MILLER. Unfortunately, I wasn't here yesterday. I had to attend another committee this morning.

I would like to get some sort of an explanation on what we mean by this technical contractor. As I get it, then, one firm comes in and it makes a contract, and the other two have to accept that or do accept that without further negotiation?

Mr. POWERS. That is right, sir.

Mr. COURTNEY. Mr. Miller, may I break in there?

Mr. MILLER. Isn't that almost legitimatizing a sort of collusion?

Mr. COURTNEY. Mr. Miller, may I make an explanation to you which I think may have been overlooked?

Three concerns were manufacturing the B–47, which had been developed originally by Boeing. At the time in question three firms were using the wing assemblies which are discussed this morning.

Boeing had the prime contract and the direct contract relationships with the producers of the wing sets, which in this case was Ford Motor Co., and those 2 of the 3 producing accepted that number of sets out of this total purchase order which were applicable to the units that they were producing.

The responsibility, however, if I understand it correctly—and Mr. Newman or Mr. Powers correct me. The responsibility for the administration, the placing of the order, and the administration of the order, was in Boeing.

Mr. POWERS. As we understand it, Mr. Courtney, Boeing negotiated the price for the quantity and the cost. Now, on the basis of the supply schedules, 57 of the wing sets were to go to Boeing, 172 were to go to Douglas, and 225 to Lockheed.

Now, both Douglas and Lockheed then issued specific purchase orders to Ford for the quantity of the wing sets to go to them.

Mr. COURTNEY. At what price?

Mr. POWERS. At the same price that had been negotiated——

Mr. MILLER. There is no other—after Boeing makes the negotiation——

Mr. POWERS. That is binding and conclusive.

Mr. MILLER. In other words, the Boeing sets a basic price, and everybody accepted it.

Mr. POWERS. Everybody has to pay it, the same as a catalog price.

Mr. MILLER. Now, the thing I want to get: Were these contracts with Ford from the other 2 companies—of course, the responsibility for payment came from the other 2 companies, or did Ford just look to Boeing—did the whole transaction pass through Boeing?

Mr. POWERS. The whole transaction was originally negotiated by Boeing, but after that point, in terms of delivery and payment for that portion of the wing sets to be delivered to them, Douglas and Lockheed had a direct relationship with Ford.

Mr. MILLER. Boeing was out of it completely after that?

Mr. POWERS. Now, Boeing had additional responsibility other than those having a direct financial relationship upon this.

For example, Boeing had a responsibility to furnish all the necessary drawings, the phototemplate of engineering master layouts and anything else of a technical character or nature.

Secondly, Boeing had responsibility to be certain that Ford exercised proper standards of quality control on the production of the wing sets.

Third, Boeing was to furnish to Ford any technical assistance found to be necessary, without cost.

Fourth, Boeing was to provide Ford all of the master gages, in connection with the production of the wing sets.

And fifth, Ford may visit the Boeing plant at any time to study the production methods with respect to the wing sets.

Now, in terms of when the deliveries were made to either Lockheed or Douglas, as we understand it, Mr. Miller, it was the responsibility of the other two companies to pay Ford for the wing sets, and not Boeing.

Mr. MILLER. So everything, then, except the financial arrangements—the relationship was between the prime contractor and the secondary, with Boeing being the prime contractor.

Mr. POWERS. Yes, sir.

Mr. MILLER. All the physical arrangements, other than the financial, were the relationship of Boeing to Ford?

Mr. POWERS. That is right.

Mr. MILLER. So the other people just came in and bought these things off the shelf from Ford, having all of it developed through Boeing?

Mr. POWERS. That is right, sir.

Mr. HÉBERT. Now, the $5 million reflects the repayment back to the Government on the overall contract as Ford had it?

Mr. POWERS. That is right.

Mr. HÉBERT. Which represents the other two companies as well as Boeing?

Mr. POWERS. Right, sir.

Mr. HÉBERT. And not directly back to Boeing. Naturally not, because it is Government money.

Mr. POWERS. That is the way we understand it, Mr. Chairman.

Mr. HÉBERT. That is it. In other words, the $5 million reflects also the returnable money on the cash paid by Douglas and by Lockheed?

Mr. POWERS. Correct.

Mr. HÉBERT. Mr. Bates.

Mr. BATES. That was the question I wanted to ask, whether or not this reflected all of the amount of money that should be turned back to the Government.

Mr. POWERS. That is right.

Mr. BATES. Or all the work that Ford did for the three different companies.

Mr. POWERS. That is the way I understand it, Mr. Bates.

Mr. BATES. Isn't that the situation?

Mr. POWERS. We have not verified it. You see, at the point in time we had the information the refund had not been made, and it was not until we received the letter from the Air Force, I think it was January 18, that they advised us that the refund had been made.

We attempted to obtain information from the Air Force, and they agreed that they would furnish it to us, but so far we have not received positive affirmative confirmation they have the refund and whom it was made to.

Mr. BATES. Well, wouldn't you normally conclude, if there were 3 separate companies paying, that the amount should be given back through each of them, rather than just 1 of them?

Mr. POWERS. Yes, sir. I think that is a reasonable determination.

Mr. BATES. Now, is somebody going to chase this down?

Mr. POWERS. We will, sir.

Mr. HÉBERT. Naturally, we are going to chase this, and many other things down, Mr. Bates.

Mr. BATES. I want to know who is going to do it.

Mr. HÉBERT. We have very good colleagues.

Mr. BATES. I just want to make sure it hasn't been done yet. It is going to be done.

Mr. POWERS. Yes, sir.

Mr. HÉBERT. Mr. Gavin?

Mr. GAVIN. The gentleman states it is going to be done. If the general counsel will recall, I believe I pressed very hard during the investigation of aircraft manufacturers, on subcontracts. Do you recall that?

Mr. COURTNEY. That is exactly why we are in this business now.

Mr. GAVIN. We are in it now.

Mr. COURTNEY. It is purchase orders, however, in this case, Mr. Gavin.

Mr. GAVIN. We got little satisfaction of how these subcontracts were let, whether they were just let promiscuously to somebody the individual wanted to give it to, and whether they called for bids on it.

I think it is a very important matter, as to whether or not small business is being blocked out because of the inability to get an opportunity to bid on these subcontracts.

The facts are that maybe a prime contractor will just—or an aircraft industry would say, "Well, this particular item is going to so and so."

Whether or not anybody was called in to get an opportunity to bid on them—I think this subcontracting business ought to be investigated very carefully, and very thoroughly, as to what is their plans, what is their procedures, and the whole setup, so the committee will understand the mechanics in this subcontracting business with these aircraft industries.

Mr. MILLER. Mr. Chairman?

Mr. HÉBERT. Mr. Miller.

Mr. MILLER. Did Lockheed and Douglas pay the same unit price, whatever it happens to be, for a wing as Boeing in this case?

Mr. POWERS. Yes, sir.

Mr. MILLER. Then where was Boeing reimbursed for the engineering and technical knowhow and all of the work that it had to go to in the development of this wing?

Mr. POWERS. Under the prime contracts with the Department of the Air Force.

Mr. MILLER. So the price of the wing, then, to Boeing, to Lockheed, and to Douglas, was the same?

Mr. POWERS. Yes, sir.

Mr. MILLER. And the development and engineering and administrative work done by Boeing—they were reimbursed for that differently or on a different basis or in some other manner.

Mr. POWERS. And also, Mr. Miller, they had had prior development contracts.

Mr. MILLER. For which they had been paid.

Mr. POWERS. Yes, sir.

Mr. MILLER. That is all.

Mr. COURTNEY. May I ask one question, Mr. Powers, for the information of the committee, and recommendations to the subcommittee.

Since a portion of these sets went to Douglas, and Lockheed, under the arrangements which you found on these contracts, was either Douglas or Lockheed in a position to question the price of the set or to redetermine on its own independently the price of the sets for which they were billed?

Mr. POWERS. Well, Mr. Courtney, they had actually as we see it no legal responsibility in the matter, and in accordance with the arrangements and the provisions of their contracts, with the Air Force, their role was reduced to that of purely accepting the price, and including it in their cost to be billed to the Government for their portion under their prime contract.

Mr. COURTNEY. Now, in your opinion, would it be an improvement in the contractual procedures in these circumstances that the other contractors who were required to pay for these sets, in the production of the same models, be given some legal responsibility or even an opportunity for redetermining the prices which they are required to pay on so substantial a unit?

Mr. POWERS. Well, Mr. Courtney, we feel that in this case the answer lies in the fact that there was in our opinion a demonstration of ineffective supervision and control by the Air Force over the whole operation.

We think the answer lies there based upon the results of our findings in this case.

Mr. COURTNEY. Rather than in distributing the responsibility over the three users.

Mr. POWERS. Yes, sir. Because in the subcontract in which Boeing did have the negotiating responsibility, involving $139 million, we think that in the interest of the Government, the administrative department, which is the Air Force, must exercise close supervision over those processes.

Mr. HESS. Boeing also had the redetermination responsibility, did it not?

Mr. POWERS. Yes, sir.

Mr. HESS. The sole responsibility.

Mr. POWERS. The sole responsibility.

Mr. HÉBERT. Do you think that this beautiful letter that has been read into the record, of the great hopes and wonderful thoughts and conglomeration of a lot of gush is the answer to the problem?

Mr. POWERS. Mr. Chairman, we feel that in this case—and I feel that is a part of our responsibility to this committee, we should say that in all fairness and objectivity of working towards the mutual and common objective of seeing that both the Government and industry have the means by which there is a proper disclosure and an equitable consideration of all factors. That the reply was not satisfactory or up to the standards of the responsiveness and the objectivity we have obtained both from General Rawlings at AMC in regard to other findings that we have developed during the past year nor to the Assistant Secretary of the Air Force's Office for Materiel.

Now, after receiving the reply, we personally contacted the Air Force officials involved and told them that we did not feel it was responsive to either our conclusions or recommendations, and accordingly after our discussions with these officials we addressed a communication back to Assistant Secretary of the Air Force, Materiel, the Honorable Dudley C. Sharp, on February 8, and advised him of the seriousness of this problem and suggested that he give it immediate attention, to take some more positive action rather than the general comments which were included in their reply of January 18.

We have not received a reply from Assistant Secretary Sharp to our second request of February 8.

Mr. HÉBERT. Well, I will ask that, if and when such a reply is received, this committee be furnished a copy of that reply.

Mr. POWERS. We will be glad to do that, Mr. Chairman, and we will send it to you promptly.

Mr. BATES. Mr. Chairman?

Mr. HÉBERT. Mr. Bates.

Mr. BATES. Does the Government actually have the $5 million in its possession now?

Mr. POWERS. I can't answer that question at this time, Mr. Bates.

Mr. BATES. Well, there was a statement in here by——

Mr. POWERS. The statement is made in the letter of January 18 from the Air Force that a refund has been obtained from Ford in the amount of $5 million. Now, we have not been able to verify the fact that they have obtained it, other than the statement contained in this letter.

Mr. BATES. Yes. Now, I had read that paragraph.

Mr. POWERS. Yes.

Mr. BATES. If I can get to the point. In the rest of the statement there, it says—

which compensates in great part for the apparent error in negotiation.

Now, that is a statement of the Air Force, rather suggestive of the fact that perhaps there is more money in there.

Mr. NEWMAN. There is, sir.

Mr. BATES. I see. I wasn't here at that time. Now, what was the modus operandi? Do you know how this money was received? Did the Air Force write a letter and say "We would like to have this money back, or thank you very much for calling it to our attention," or have you seen anything in the files on that at all?

Mr. POWERS. So far as we could determine, Mr. Bates, Ford voluntarily offered to refund the amount of $5 million.

Now, our audit was made during—June to August 1955. Our findings were discussed with Ford in August 1955.

Mr. BATES. So you don't know if they actually got the money and, therefore, you don't know how it was actually accomplished.

Mr. POWERS. No, sir; at this time, we don't.

Mr. BATES. Thank you, Mr. Chairman.

Mr. COURTNEY. And you are not able to explain, then, what distribution, if any, was made of the $5 million?

Mr. POWERS. Not at the present time.

Mr. HESS. Do you think there is any possibility of recovering that $4,800,000 under renegotiation?

Mr. POWERS. No, Mr. Hess, unless Ford Motor Co. were to voluntarily offer to refund it.

Mr. HÉBERT. Mr. Cunningham, have you any questions?

Mr. CUNNINGHAM. No questions.

Mr. HÉBERT. Any further questions?

Mr. HESS. Under renegotiation?

Mr. POWERS. It may be possible.

Mr. HÉBERT. Any further questions from members of the committee, in connection with this matter? Thank you, gentlemen, very much.

We will look forward to this continued fine cooperation from the General Accounting Office, and from you, individually.

Mr. POWERS. Thank you, Mr. Chairman and members of your committee, for your time, and consideration of our findings and report.

Mr. HÉBERT. I think together we can save untold millions to the Government.

Mr. POWERS. Thank you, sir.

Mr. HÉBERT. The committee will now recess until Monday at 10 o'clock.

(Whereupon, at 11:25 a. m., the subcommittee recessed, to reconvene at 10 a. m., Monday, April 1, 1957.)

APPENDIX A

COMPTROLLER GENERAL OF THE UNITED STATES,
Washington, February 8, 1957.

B-118715

Hon. CARL VINSON,
Chairman, Committee on Armed Services,
House of Representatives.

DEAR MR. CHAIRMAN: Enclosed for the use of your committee is a copy of our report on review of Boeing purchase order 952359 (contract AF 33(038)-21407) between Boeing Airplane Co., Air Force prime contractor, and the Ford Motor Co., subcontractor. This report, which includes the comments of Headquarters, Air Materiel Command (AMC) on our findings, was transmitted to the Assistant Secretary of the Air Force (Materiel) on November 5, 1956. A copy of his reply, dated January 18, 1957, is attached to this letter.

We believe that this report shows the need for closer control by the Air Force over the repricing of major subcontracts. In commenting on the repricing negotiations between Boeing and Ford, AMC acknowledged that there were weaknesses in negotiations and stated that an anticipated $5 million refund from Ford would make up for the apparent error in negotiations and would also give the Air Force a share in economies due to Ford's efficiency. In his letter dated January 18, 1957, the Deputy Assistant Secretary of the Air Force (Materiel) informed us that the comments we received from AMC reflect, in general, the Air Force views on our report. He agreed that the negotiations between the prime contractor and subcontractor left much to be desired and stated that the $5 million refund referred to by AMC had been obtained.

In bringing this matter to the attention of the Air Force our purpose was to disclose apparent administrative weakness for consideration of the Air Force and advice as to actions taken to avoid reoccurrences.

Although the Air Force mentioned general programs of improvement and instruction, they did not indicate specifically what measures have been taken to overcome the particular type of weakness disclosed in this case.

We are pursuing this matter further on the basis indicated in the attached copy of a letter to the Air Force, dated February 8, 1957.

Sincerely yours,

JOSEPH CAMPBELL,
Comptroller General of the United States.

APRIL 29, 1957.

Re your file B–118715, Boeing-Ford Motor Co. subcontract.

Hon. JOSEPH CAMPBELL,
Comptroller General of the United States,
Washington, D. C.

DEAR MR. COMPTROLLER GENERAL: Thank you for your letter of April 23, 1957, enclosing an exchange of correspondence between Hon. Dudley C. Sharp, Assistant Secretary of the Air Force, under date of March 29, 1957, and your response thereto of April 23, 1957, referring the correspondence to the subcommittee.

Your continuing interest in this matter is greatly appreciated.

Sincerely yours,

F. EDWARD HÉBERT, *Chairman.*

COMPTROLLER GENERAL OF THE UNITED STATES,
Washington, D. C., April 23, 1957.

Hon. F. EDWARD HÉBERT,
Chairman, Subcommittee for Special Investigations,
Committee on Armed Services,
United States House of Representatives.

DEAR MR. CHAIRMAN: In accordance with your request during the hearings on March 29, 1957, there is attached a copy of a letter dated March 29, 1957, from the Honorable Dudley C. Sharp, Assistant Secretary of the Air Force, in reply to a letter from this Office dated February 8, 1957, concerning our report on review of Boeing Purchase Order 952359 between Boeing Airplane Co., Air Force prime contractor, and Ford Motor Co., subcontractor.

There is also attached a copy of our letter dated today to Secretary Sharp concerning further action to be taken relative to the specific measures contemplated by the Air Force to strengthen controls over subcontract pricing.

Sincerely yours,

JOSEPH CAMPBELL,
Comptroller General of the United States.

UNITED STATES GENERAL ACCOUNTING OFFICE,
DEFENSE ACCOUNTING AND AUDITING DIVISION,
Washington, D. C., April 23, 1957.

Hon. DUDLEY C. SHARP,
Assistant Secretary of the Air Force.

DEAR MR. SHARP: In accordance with the request of Representative F. Edward Hébert, we have today transmitted to the Subcommittee for Special Investigations of the House Committee on Armed Services, a copy of your letter dated March 29, 1957, relating to our report on review of Boeing Purchase Order 952359 between Boeing Airplane Co., Air Force prime contractor, and Ford Motor Co., subcontractor.

We appreciate your prompt and objective consideration of our findings. It is apparent that the subcontract pricing problem is recognized by the Air Force and is receiving attention. However, the specific measures contemplated to place greater control over subcontract pricing are not entirely clear and we believe that the Air Force might well reappraise its emphasis upon early repricing.

Mr. James H. Hammond, Assistant Director of this Division, has been requested to discuss with representatives of your office the specific actions and

measures contemplated with regard to the establishment of firm prices in those cases where the contractor feels that his cost data is not sufficiently reliable for such purposes.

Sincerely yours,

WILLIAM A. NEWMAN, Jr.
(For Lawrence J. Powers, Director.)

DEPARTMENT OF THE AIR FORCE,
OFFICE OF THE SECRETARY,
Washington, March 29, 1957.

DEAR MR. POWERS: We have carefully studied your letter B–118715 of February 8 and the question of whether current Air Force procedure provides sufficient control over the Boeing-Ford subcontract type problem to adequately protect the Government's interest. You suggest that—

(*a*) Instructions or regulations be established which would require special measures and safeguards over pricing of large subcontracts and of subcontracts where there is a lack of incentive to reduce cost; and that

(*b*) The Air Force reconsider the advisability of insisting that a supplier finalize his price if he feels that he has insufficient cost data.

Air Force pricing policy currently provides that special measures and safeguards be related to the substance of procurement whether prime or sub. All of our authority and review requirements emphasize the importance of high dollar value. Pricing training is directed toward emphasis on the important. You have already been furnished copies of directive material and AMC Manual 70–3 on the subject of subcontract pricing.

We do not believe that there is a weakness in instructions or regulations. The job appears to us to be one which can best be solved by specialized training measures. This we are doing and will continue. We will, however, accept your suggestion and place additional emphasis on the major subcontract pricing problem.

For your information, in a recent speech to the Air Force Advanced Pricing School, the Director of Procurement and Production, Headquarters, Air Materiel Command, included the following:

"In addition to pricing the prime contract, I will expect good pricing people to make sure that our prime contractors are meeting their responsibility in pricing their subcontracts. The subcontract pricing problem is one of the most challenging pricing areas at the present time and I expect you to contribute to doing the job better."

Your second question relates to the time of finalizing a price in a IIB-type contract. We have two thoughts: The first, that firm pricing must be supported by adequate cost information; second, that other things being equal, the earlier that prices are finalized the better.

Where cost data proves insufficient at the contract time contemplated for repricing, there is, of course, a question whether the IIB-type contract should have been entered into. Recognizing the impossibility of converting to a more appropriate type of contract at a later date, we believe that (i) where a contractor's failure to negotiate a sound price on a timely basis results in a reduction of risk, then (ii) a reduction in profit consideration is in order.

Our experience with interim repricing contracts has improved vastly since the time of the Boeing-Ford negotiation. At that time, as you know, many of our IIB contracts were running to completion before redetermination and all efforts were directed toward earlier pricing. It is impossible to determine at this time whether or not there was then sufficient cost data at Ford for adequate pricing, but we are satisfied that neither Boeing nor the Air Force would have proceeded had they felt the data to be insufficient.

The values to be gained from early repricing are obvious to both of us. If, in the instant case it would have been better to have delayed repricing, then the case was an exception rather than the rule. We certainly agree, however, that we cannot rely upon a voluntary refund as a part of our pricing technique; however, our efforts in obtaining the voluntary refund from Ford should be recognized as a part of the overall procurement in this case.

Since receiving your letter, our Air Materiel Command pricing people have been privileged to discuss with you many of our general pricing policies. We feel that we have much to gain from your review of our pricing practices. We think that discussions of pricing policy should take place whenever a practice indicates that the Air Force may not have provided adequate pricing direction.

Certainly, the implementation of our policy is dependent upon many individual buying people. Recognizing that directive material alone will not solve our problem, you will find that we are not wholly anxious to give them guidance, but also to concentrate on a training and surveillance program that will insure that operations are consistent with our aims.

We look forward to further cooperation with you and your people.

Sincerely yours,

DUDLEY C. SHARP,
Assistant Secretary of the Air Force.

Mr. LAWRENCE J. POWERS,
Director, Defense Accounting and Auditing Division,
United States General Accounting Office.

FRIDAY, JULY 12, 1957

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE FOR SPECIAL INVESTIGATIONS,
Washington, D. C.

The subcommittee convened at 10 a. m., the Honorable F. Edward Hébert, chairman of the subcommittee, presiding, and the following members present: Mr. Hess, Mr. Gavin, Mr. Cunningham, and Mr. Hardy.

Mr. HÉBERT. The committee will come to order.

Mr. COURTNEY. Mr. Chairman, at the conclusion of our hearings on the Boeing-Ford presentation by the General Accounting Office by Mr. Powers and his assistants—reporting on a finding and certain facts supporting the same, by the General Accounting Office, we received a telegram from Boeing Airplane Co. which I should like to read into the record.

This is dated April 3, 1957, directed to the chairman. It states [reading]:

I feel obligated to comment upon the newspaper accounts of the testimony of Mr. Lawrence J. Powers, of the General Accounting Office, before your subcommittee on March 29, 1957. The inferences and accusations allegedly made by Mr. Powers that Boeing and the Air Force, to the point of negligence, were not interested in protecting the interests of the Government with respect to the subcontract with Ford Motor Co. for B–47 wings, are flagrantly erroneous. When the Boeing Co. became aware of cost trends being experienced by Ford subsequent to the negotiation of the Ford subcontract, Boeing representatives contacted Ford on numerous occasions concerning the possibility of a refund. Upon such contacts, Ford reiterated that, in their opinion, they were not experiencing excessive profits and that a refund was not indicated. When the Ford Co. finally acknowledged the possibility of a refund on November 4, 1955, the Air Force and Boeing immediately, in connection with the final price negotiations on B–47 contract AF33/600/5148, entered into supplemental agreement No. 73. This formal contractual supplement was negotiated during the period November 7–8, 1955, and paragraph 13 therefore is quoted verbatim below:

"It is recognized that the price negotiated herein for category first does not include an allowance for a possible refund from the Ford Motor Co as a result of its production of B–47 wings for Boeing, Douglas, and Lockheed. It is agreed by the parties hereto that the contractor's portion of any such refund allocable to contract 5148 will be returned to the Government in its full amount."

Again, contrary to Mr. Powers' reported testimony, the actual refund on the Boeing subcontract was received by Boeing to the Government on November 9, 1956. In view of the record, I am at a loss to comprehend how Mr. Powers could have concluded that the Air Force and Boeing were not interested in the refund, since the General Accounting Office has access to Air Force contracts, including contract AF33/600/5148. Furthermore, Mr. Powers allegedly testified that Ford had contacted Boeing requesting an adjustment in the subcontract to take care of the refund, and that Boeing replied that it could not

afford to change the contract. This is a misstatement of fact. The Ford Co. did not contact the Boeing Co. regarding such a request at any time. As to whether or not we can afford to make such adjustments, we spend considerable time and effort in assisting subcontractors, providing them with on-the-spot technical know-how, including the training of their personnel in improved aircraft manufacturing techniques. All of these efforts are directed toward enabling them to achieve better cost performance which permits contract price reductions and refunds. In fact, our records indicate we have processed numerous reductions to vendor purchase orders and have passed appropriate credits to related prime contracts for as low as $1,600. You were quoted as expressing concern that the Boeing Co. had failed to list the Ford Co. as a subcontractor in the data presented last year to your subcommittee. The Ford subcontract was properly listed on page B–3.4 of our answer to the questionnaire. Your inability to find the listing of the Ford subcontract was undoubtedly due to another discrepancy in Mr. Powers' testimony, when he referred erroneously to contract AF33/038/21407 instead of AF33/600/5148. A copy of the complete testimony has been requested, and will be reviewed. After review, the Boeing Co. will welcome an opportunity to appear before your subcommittee with the objective of clarifying many apparent misstatements and misinterpretations of fact with respect to the subcontract with Ford Motor Co. for B–47 wings.

Mr. Clyde Skeen, our controller, will be in Washington on April 9 and 10 on other matters, and will call your office to ascertain if you desire to discuss with him an appearance before your committee.

Respectfully,

WILLIAM M. ALLEN,
President, Boeing Airplane Co.

Mr. Chairman, I would ask that telegram be made a part of the record of the prior hearing.

Mr. HÉBERT. Without objection.

Mr. COURTNEY. Now, Mr. Chairman, on April 9, as the telegram indicated, Mr. Clyde Skeen, the controller of the company, Mr. James P. Murray, its local representative, and Mr. Carl Dillon, waited on the subcommittee, and myself.

In the interview with Mr. Skeen and his associates, I advised them, with your consent and direction, that if there were any controversy with respect to the facts or the conclusions in the General Accounting Office report, that the first thing that should be done would be to reconcile those differences with the General Accounting Office. That the subcommittee did not consider it appropriate to engage in that controversy at this point, or to supervise a controversy between General Accounting Office, and the Boeing Airplane Co., since the General Accounting Office had made a firsthand investigation and had submitted its factual report to the subcommittee.

So conferences ensued. How many I do not know, precisely. But we were advised by the General Accounting Office representatives from time to time that the conferences were progressing and that the facts would be ironed out.

On June 27, 1957, the General Accounting Office addressed a letter to the subcommittee. It is No. B–118715, which I should like to present to the subcommittee now.

Mr. Chairman, we have a limited number of copies here, but I will pass some of them around to the subcommittee. This is addressed to the subcommittee. [Reading:]

In accordance with your suggestion of April 9, 1957, to Mr. Clyde Skeen, controller, Boeing Airplane Co., we have met with Boeing representatives to discuss certain aspects of our report on the purchase orders issued to the Ford Motor Co. for B–47 wings, and our testimony thereon to the Subcommittee for Special Investigations on March 20, 1957. The following Boeing representatives participated in the discussion: Mr. James P. Murray, vice president, Washington repre-

sentative; Mr. Clyde Skeen, controller; and Mr. Carl Dillon, director of finance, of Wichita division.

Our discussions were concerned primarily with the question of Boeing's interest or efforts in obtaining a refund from Ford and the prime contract number under which the purchase orders were reported. We have reached an agreement with the Boeing representatives that the attached memorandum is a factual presentation of the circumstances related to these questions.

A copy of this letter is being forwarded to the Boeing Airplane Co.

That is signed "Very truly yours, Lawrence J. Powers, Director of the Defense Accounting and Auditing Division," and the number of the official letter is B–118715.

The attachment, Mr. Chairman, represents the agreed statement of facts. [Reading:]

Evidence or lack of evidence of interest in or efforts by Boeing to obtain refund from Ford.

The rate of profit being experienced by Ford was considered excessive by the Air Force resident auditor at Ford and was called to Boeing's attention on three occasions.

Letter dated July 19, 1954, from the Air Force resident auditor at Ford to the Air Force plant representative at Boeing stated that the indicated rate of profit experienced by Ford far exceeded the expected and negotiated profit. This letter was forwarded to Boeing by the Air Force plant representative for review and comment on July 22, 1954. Boeing, in a letter to the Air Force plant representative dated July 23, 1954, stated that (1) the information in the resident auditor's letter was not sufficient for Boeing to determine that the profit as shown was excessive and (2) in Boeing's opinion if Ford experienced an excessive profit they would voluntarily make a refund.

These, I might remark parenthetically, refer, quite obviously, to the exhibits which were attached to the presentation made by the General Accounting Office. [Continues reading:]

In a letter dated October 22, 1954, to the Air Force plant representative at Boeing, the Air Force resident auditor at Ford stated that information developed from control schedules furnished by Ford indicated profits of 17 percent at 86 percent of completion of the contract, and a forecast for the balance of production indicated that the contract would be completed with profits in excess of normal or negotiated. This letter was forwarded by (sic) Boeing by the Air Force plant representative on October 25, 1954. In commenting on the Air Force resident auditor's letter, Boeing in a letter dated November 8, 1954—

Mr. HÉBERT. To Boeing.

Mr. COURTNEY. To Boeing. [Continues reading:]

In commenting on the Air Force resident auditor's letter, Boeing in a letter dated November 8, 1954, to the Air Force plant representative at Boeing stated that (1) the resident auditor's statement appeared to be an opinion and did not necessarily take into account certain conditions and unrecorded costs through completion and (2) in Boeing's opinion, based on known conditions and cost trends at the time of price redetermination negotiations, the fixed prices were fair and reasonable and information made available subsequently furnished no basis for alarm or change of their opinion.

Letter dated November 15, 1954, from the Air Force resident auditor at Ford to the Air Force plant representative at Boeing pointed out that (1) his letter of October 22 was not an opinion but was based upon recorded costs and forecasts made by Ford and (2) actual profits appeared to exceed the amount negotiated by $10 million. The Air Force plant representative at Boeing submitted this letter to Boeing for consideration. On November 19, 1954, Boeing forwarded to Ford, Kansas City, the Air Force resident auditor's letters of October 22 and November 15, and Boeing's letter to the Air Force, dated November 8, stating that after this problem was discussed with Mr. Beers (of Ford Motor Co., Detroit), Boeing would appreciate a call so they could get together with Ford for an answer to the latest Air Force letter.

The reply from Ford dated January 12, 1955, defended the negotiated price, stated that the profits that would be earned during the period of March 1, 1951,

to June 30, 1956, would be less than Ford had anticipated from the program and cited reasons why the profits should be retained. A meeting of Ford and Boeing officials was held on January 13, 1955, to discuss the January 12 letter. Ford's memo of this meeting states, in part:

"Mr. Schaefer (Boeing) stated that both the Air Force and Boeing usually gage performance by comparing profits with either costs or sales, and that it may have been advisable for Ford to have presented an evaluation on this basis. Ford representatives reemphasized that the return on assets employed is a basic profit evaluation instrument and since, unlike most airframe programs the Ford wing program is being performed in a company-owned facility it must be used in this case to permit true evaluation.

"Mr. Schaefer asked Mr. Dillon's (Boeing) opinion as to the sufficiency of Mr. McNamara's (Ford) letter with respect to acquainting the Air Force with profit performance on the Ford wing program. Mr. Dillon replied that with the addition of certain other information similar to that contained in various letters written by the Kansas City aircraft plant resident auditor, it was in his opinion sufficient.

"(Parentheses added for identification purposes.)"

Boeing in a letter dated February 14, 1955, to the Air Force plant representative at Boeing, Wichita, referred to the meeting with Ford representatives to discuss various correspondence and actions that had taken place as a result of the letters forwarded by the Air Force resident auditor at Ford Motor Co., Kansas City division. Boeing stated that they had no access to records at Ford (other than through the reports of the Air Force resident auditor at Ford) and could only report their understanding of Ford's position relative to the claim of the resident auditor regarding any excessive profits. Boeing then concluded their letter by stating that inasmuch as final fixed prices were negotiated in good faith with Ford and were considered fair and reasonable, any subsequent action insofar as Boeing was concerned relative to these prices could only be on a voluntary basis on the part of Ford Motor Co., and Ford did not believe that they had earned excessive profits.

Boeing believes that their action (mentioned above) which obtained a written statement of policy from Ford with respect to profits, constitutes a showing of interest on their part in obtaining a refund.

Our review disclosed that there is no evidence that Boeing requested a refund from Ford. In our opinion the records examined and evidence submitted clearly indicate that this exchange of correspondence early in 1955 closed the matter as far as Boeing was concerned. Boeing's reply of November 3, 1955, to our findings dated October 19, 1955, defended the date of redetermination of price under the purchase order, as well as other points that were raised by our tentative report, and no mention was made of a possible refund from Ford. However, Boeing's intradivision letter dated November 4, 1955, indicates that Boeing, Wichita, had received a telephone call from Ford advising that a $5 million refund would be made.

2. Prime contract number:

Apart from the findings contained in our report and our testimony thereon during the course of the hearing, the subcommittee commented on Boeing's failure to report the Ford subcontracts to the subcommittee under the original contract number during the hearings on aircraft production costs and profits during the spring of 1956.

In further clarification of this point, it should be that on page 1902 of the hearings before the Subcommittee for Special Investigations of the Committee on Armed Services, House of Representatives, 84th Congress, 2d session, Boeing listed Ford subcontracts (without identifying individual subcontract numbers) in the total amount of $29,200,718, under contract No. AF33/600/5148, the contract under which the wing sets were to be used as provided by change orders to the original purchasing orders.

The Air Force prime contract No. AF 33(038)-21407 was included in our report for the purpose of identifying the original contract under which the purchase orders were issued to the Ford Motor Co. for the B-47 wings. However, change order No. 13, dated November 27, 1951, to Boeing purchase order 952359 and change order No. 12, dated March 27, 1952, to Boeing purchase order No. 952360 transferred the subcontracts from contract AF 33(038)-21407 to AF 33(600)-5148.

The fact that the wings were used by Boeing under another Government prime contract of the same type had no particular significance to our examination

of the operations and administration of the B–47 wing program performed under subcontracts by the Ford Motor Co. The change in the prime contract under which the wing sets were utilized did not alter the fact that, as we reported to the Congress, there was insufficient control by the Air Force over the negotiations between Boeing and Ford of subcontract prices under which Ford realized $9.8 million profit in excess of that contemplated.

Mr. Chairman, that concludes the agreed statement of facts submitted as indicated in the letter of transmittal to the subcommittee.

Mr. Chairman, immediately after I received, in behalf of the subcommittee, the letter and the statement which I have just read, I sent an airmail certified mail letter to Mr. Clyde Skeen, the controller of Boeing Aircraft at Seattle.

I would like to read that into the record. [Reading:]

On April 9, 1957, in conference with the undersigned, the representations made in your telegram to the subcommittee of April 3, 1957, signed by Mr. William M. Allen, your president, were discussed and it was suggested that your differences concerning facts be first discussed with and reconciled with the General Accounting Office whose report was made to the subcommittee.

The subcommittee is informed that in the interval several conferences have been held. Today, the subcommittee is in receipt of a letter from the General Accounting Office dated June 27, 1957, containing a summation of the matters discussed in the conference between your company's representative and those of General Accounting Office.

Appended to the transmittal is a statement of facts agreed upon.

Mr. Chairman, that is the letter and statement I have just read from the General Accounting Office. [Continues reading:]

Your company has been furnished a copy of this transmittal made to the subcommittee. The subcommittee desires confirmation of the content of the letter of the General Accounting Office with its statements of facts for further proceedings in this matter. Kindly give this matter your prompt attention and advise the subcommittee in the premises.

Now, Mr. Chairman, that was June 28, 1957.

This meeting, as you know, was scheduled some weeks ago. Not having had a reply, on July 9, 1957, I wired the president of the Boeing Airplane Co., at Seattle, Wash., as follows [reading]:

Reference subcommittee airmail letter June 29, to Clyde Skeen, controller, concerning statement of facts presented by General Accounting Office, June 27. Immediate reply was requested. None received to date.

That afternoon, I received in behalf of the subcommittee a telegram reading as follows [reading]:

Subcommittee letter received July 2. The reply which has been coordinated with and approved by the undersigned being airmailed July 9, 1957.

(Signed) WILLIAM M. ALLEN,
President, Boeing Airplane Co.

Now, Mr. Chairman, we come to the letter from Boeing Airplane Co., in response to the subcommittee's letter.

Mr. GAVIN. May I ask a question?

Mr. COURTNEY. Yes, sir.

Mr. GAVIN. On that call to Wichita from Ford to Boeing, that was a voluntary call, was it, to Boeing, advising them they were returning $5 million. Ford called Boeing. Boeing didn't call Ford—in the latter part of your statement here. I can't recall that.

Mr. COURTNEY. That, Mr. Gavin, is from an agreed statement of facts. That is nothing with which I had anything to do.

Mr. GAVIN. Oh.

Mr. COURTNEY. That was agreed—which I had nothing to do with nor anybody in behalf of the subcommittee had anything to do with. That is an agreed statement of facts.

Mr. GAVIN. Oh. Well, I was just wondering who put in the call. Did Ford put in the call to Boeing at Wichita, advising them they were returning $5 million?

Mr. COURTNEY. That is correct. And the original presentation to the subcommittee made on the March 29 hearing makes reference to that exchange as being a telephone call. Now, how it originated we don't know.

Now, this is the letter from Boeing of July 9, 1957, which was received on July 11, 1957, addressed to the subcommittee. [Reading:]

This is in reply to your letter dated June 28, received by this office July 2. Following our discussion in your office on April 9, 1957—

that refers to the subcommittee—

the undersigned and other representatives of the Boeing Co. met on three separate occasions with Mr. Lawrence J. Powers, Director of Defense Accounting and Auditing Division, United States General Accounting Office, and members of his staff. The purpose of these meetings, as suggested by you, was to attempt to reconcile difference of fact relating to Mr. Powers' testimony on March 29, 1957, before the subcommittee concerning the subcontract for B-47 wings between the Ford Motor Co. and the Boeing Co.

Mr. William Allen's telegram of April 3, 1957—

which I have read into the record—

to the chairman of the subcommittee was directed to the newspaper accounts of Mr. Power's testimony. (See for example attachments A and B from the New York Times and the Washington Post and Times Herald.)

Mr. Chairman, we have not reproduced in the copies on your desk the attachments. Attachment A is an article which appeared in the New York Times. The date is indistinct. But the dateline is March 29. The byline is the Associated Press.

Attachment B is an article which appeared—there is a marking on it "March 30, 1957," which appeared in the Washington Post and Times Herald. The byline is the United Press. [Reading:]

As indicated in Mr. Allen's TWX, a complete verbatim testimony of Mr. Powers' remarks was requested. This stenographic transcript, distributed by the Capitol Reporting Service of 939 D Street NW., Washington, D. C., was subsequently obtained and subjected to review.

After review of the transcript it was determined by the undersigned that there were six specific items of the testimony subject to challenge as to accuracy of fact. During the discussions with representatives of the General Accounting Office it was determined that four of the items were not of sufficient importance to the overall import of the testimony to merit further consideration. They were, therefore, dismissed from the discussions, and the primary emphasis was directed toward the question of the showing of interest by Boeing in obtaining a refund from Ford and the proper prime contract number under which the Ford wings were utilized by Boeing.

With respect to the matter of a showing of interest by Boeing in obtaining a refund from Ford, we have agreed jointly with the General Accounting Office on a statement of facts, a copy of which is appended hereto as attachment C.

Mr. Chairman, the attachment is the same text as that which I read in the letter of transmittal by the General Accounting Office. [Continues reading:]

However, we differ with the General Accounting Office in the conclusions reached therefrom, as indicated by attachment C. A fixed price contract had been negotiated between Boeing and Ford, and, in the absence of a showing of fraud by Ford, Boeing was obligated to comply with the terms of the contract.

Mr. HESS. Mr. Courtney, right there, wasn't that an incentive contract?

Mr. COURTNEY. A fixed price, redeterminable contract, as to which the target date and the target price was redetermined during the course of the contract, and was in fact redetermined.

Mr. FOGO. It wasn't incentive type, though.

Mr. COURTNEY. No, not incentive. Price-redetermined contract.

Now, Mr. Chairman, I do not desire, by having read this into the record, to associate myself in any way with the conclusions of the writer.

I would say as a matter of comment to the subcommittee that I find no basis in fact, no justification in law, and none on moral grounds, to the conclusion that is stated. [Reading:]

However, Boeing carried on discussions with Ford to ascertain the basis of Ford's contention that the profits earned under the contract were reasonable. The charge made in newspaper accounts that Boeing was unwilling to accept in behalf of the Government a voluntary refund is completely disproved.

I might say, Mr. Chairman, that is obviously the conclusion of the writer, since the committee has expressed no opinion on the subject. [Continues reading:]

Furthermore, contrary to the record and the attendant publicity, Ford contended that the negotiated price was reasonable and resisted a refund. (See Attachment C.) It is clear that the public was given a completely erroneous impression of the transaction. (See Attachments A and B.)

They are the two articles, one of the Associated Press and the other of the United Press. [Continues reading:]

This false impression should be corrected.

With respect to the proper prime contract number under which the purchase order subcontract to Ford was applicable, the General Accounting Office is now in agreement with us, as also disclosed by Attachment C. Statements were made by the chairman and you—

referring to myself—

on pages 1261, 1320, 1321, 1322, 1323, 1324, and 1325, et seq., of the stenographic transcript to the effect that the Boeing Co. had failed to include the Ford Co. as a subcontractor in the comprehensive financial data filed with the subcommittee in the 84th Congress. The agreed statement (attachment C) verifies that contract AF33(600)–5148 was the proper contract number under which the wing sets obtained from Ford were used, and on page 1902 (table B–3.3) of the record of subcommittee hearings you will note that the subcontract with Ford is listed as the ninth item in the schedule of subcontractors. We, therefore, request that the record be corrected to eliminate the statements of improper reporting on the part of the Boeing Co. to the subcommittee during the 84th Congress.

A copy of this letter is being furnished to the General Accounting Office.

Signed, "Very truly yours, Boeing Airplane Co., Clyde Skeen, comptroller," with three attachments.

Mr. Chairman, I would ask that this transmittal be made a part of the record.

(Attachments A and B are as follows:)

ATTACHMENT A

[From the New York Times, March 30, 1957]

AIR FORCE SPURNED $5 MILLION REFUND, HOUSE UNIT IS TOLD

By the Associated Press

WASHINGTON, March 29.—A Government accountant told incredulous Members of Congress today that it sometimes was easier for a company to make $5 million on a Federal contract than to get the Air Force to accept a refund.

The situation was unfolded before a House Armed Services subcommittee by Lawrence J. Powers, head of accounting and auditing for the General Accounting Office. Involved were the Air Force, the Ford Motor Co., and the Boeing Airplane Co.

Mr. Powers said Boeing contracted with Ford for 454 sets of wings for B–47's it was producing. After Ford had started production, the contract was revised and Ford's profit jumped from $9,900,000 to $21,800,000.

Ford felt this was too much and asked Boeing to revise the contract again. But Mr. Powers said Boeing replied that it could not afford to keep changing the terms. Ford then offered the $5 million to the Air Force.

F. Edward Hébert, subcommittee chairman, Democrat of Louisiana, asked whether Mr. Powell meant that Boeing and the Air Force "showed no interest in recovering this $5 million from Ford, even though the auto company "insisted on giving it back."

"We found no evidence that the Air Force or Boeing had endeavored to obtain a refund from Ford," Mr. Powers replied.

But he said Ford, seizing the initiative, submitted a "written commitment" to the Air Force for the refund and the money now is on its way to the Treasury.

Mr. Powers said Max Golden, Deputy Air Force Secretary for Procurement and Production, told him the Air Force did not like to take refunds in such cases because contractors might want it to make good on "unanticipated price increases."

Mr. Powers said the Air Materiel Command told him the situation arose because of Ford's "outstanding efficiency" in cutting costs, plus "faulty" cost projections and weaknesses in contract negotiations.

After hearing the evidence, Mr. Hébert said he feared the case was "one of many which we will be able to uncover."

ATTACHMENT B

[From the Washington Post and Times Herald, March 30, 1957]

BEATEN-DOWN AIR FORCE TAKES $5 MILLION FORD REFUND

By United Press

A Government accountant told incredulous Congressmen yesterday that it some times is easier to make $5 million on a Federal contract than to get the Air Force to accept a refund.

The unusual situation was unfolded before a House Armed Services Subcommittee by Lawrence J. Powers, head of accounting and auditing for the General Accounting Office. Involved were the Air Force, Ford Motor Co., and Boeing Airplane Co.

Powers said Boeing contracted with Ford for 454 sets of wings for B–47's it was producing. After Ford started production, the contract was revised and Ford's profit jumped $9.8 million to $21.8 million.

Ford felt this was too much and asked Boeing to revise the contract again. But Powers said Boeing replied that it could not afford to keep changing the terms. Ford then offered the $5 million to the Air Force.

Subcommittee Chairman F. Edward Hébert (Democrat, Louisiana) asked whether Powell meant that Boeing and the Air Force "showed no interest in

recovering this $5 million from Ford," even though the auto firm "insisted on giving it back."

"We found no evidence that the Air Force or Boeing had endeavored to obtain a refund from Ford," Powers replied.

But he said Ford, seizing the initiative, submitted a "written commitment" to the Air Force for the refund and the money now is on its way to the Treasury.

Powers said Max Golden, Deputy Air Force Secretary for Procurement and Production, told him the Air Force doesn't like to take refunds in such cases. If it does, contractors want it to make good on "unanticipated price increases" too.

Powers said the Air Materiel Command told him the situation arose because of Ford's "outstanding efficiency" in cutting costs, plus "faulty" cost projections and weaknesses in contract negotiations.

Mr. COURTNEY. Mr. Chairman, this letter is noted as having been transmitted, by copy, to the General Accounting Office, and I personally transmitted a copy of it yesterday upon receipt to the General Accounting Office, who have no comment to make upon its contents.

Mr. Chairman, that concludes the written record of the transaction which was discussed before the subcommittee by the General Accounting Office representatives on March 29 and is, I believe, it is fair to say from the agreed statement of facts and the other data, all of the information, data, facts, and parenthetical conclusions, upon which the committee can consider any conclusions which it desires to express.

Mr. HARDY. Mr. Chairman——

Mr. HÉBERT. Mr. Hardy.

Mr. HARDY. I would just like to ask Mr. Courtney a question. I don't want to get into any discussion of the opinions expressed by the writer, but I would like to know concerning this listing of the contracts which is referred to in the last paragraph of the Boeing letter.

Mr. COURTNEY. Yes.

Mr. HARDY. As I recall it, there was considerable doubt that Boeing had in any event provided the subcommittee with information concerning this subcontract which enabled us to identify it.

Now the contention is made that it was so recorded and we just didn't find it out because there had been a juggling of contract numbers. Now, is that correct?

Mr. COURTNEY. Yes, that is admitted, Mr. Hardy. It is admitted that the contract was listed under what I will describe as the second of two contracts from B–47 wing sets—second in order of time and second in order of appearance—in the subcommittee record of the hearings. (Note: Hearing on Airport Costs and Profits, 84th Congress.)

Now, the purchase order, as you may recall from the statement of facts, that is the number of the purchasing order, which is the identification mark, remains, however, the same in the agreed statement of facts.

Now, let me amplify that a little further. This purchase order to which the reference has been made and upon which the excess profits were earned represents a great deal more in total dollars than the number listed in the subcommittee's report.

Mr. HARDY. Well, that is the question that bothered me.

Mr. COURTNEY. In 1955. The amount reported, properly identified by Air Force contract number and by what is admittedly the

same purchase order number, shows a total of—in round figures—$29 million, in the hearing during the 84th Congress.

Now, might I say, Mr. Chairman, and Mr. Hardy, of course, when we received this information from the General Accounting Office, we did check the printed record with the subcommittee, and upon advice that there had been this error we did refer it to the point at which a portion of the money referred to in the total of this contract was listed as a purchase order.

Mr. HARDY. Let me make this further inquiry. Do I understand that Boeing actually listed both of these subcontracts with Ford? There were two subcontracts with Ford for these wing assemblies, weren't there?

Mr. COURTNEY. No, there was one subcontract with Ford, which is a purchase order——

Mr. HARDY. How did we get two different contract numbers?

Mr. COURTNEY. Those are two Air Force contracts, and these were wing set assemblies to be used, and I guess in fact were used——

Mr. HARDY. Actually, then, there was only one contract between Boeing and Ford?

Mr. COURTNEY. There was only one contract between Boeing and Ford. There were two contracts between Boeing and Air Force.

Mr. HARDY. Then one contract between Boeing and Ford was to supply wing assemblies for two contracts between Boeing and the Air Force?

Mr. COURTNEY. That is right.

Mr. HARDY. Then, did Boeing in its reporting to the subcommittee, break down or indicate its subcontract with Ford with respect to both of those two Air Force contracts?

Mr. COURTNEY. No, sir; only with one.

Mr. HARDY. Did they show with respect to one, the total contract for both contracts?

Mr. COURTNEY. No.

Mr. HARDY. Then, the thing is still misleading.

I am grieved, Mr. Chairman, when I see a company like Boeing come in here with opinions and basing ethical considerations on what seems to be legal technicalities. It just sort of causes me to lose faith in our whole system and faith in human nature.

Mr. HÉBERT. Mr. Courtney, when you were reading from the Boeing letter, did you include the exhibits of the two newspaper articles in the record?

Mr. COURTNEY. I asked that they be included, Mr. Chairman. I did not read them into the record. I have them here.

Mr. HÉBERT. Of course, I have no inclination to defend or condemn what conclusions anybody draws from a newspaper article.

I think in fairness to the newspaper associations so named, that their articles should be made part of the record.

Mr. COURTNEY. I have so requested, Mr. Chairman. I understood that the committee assented to it.

Mr. HÉBERT. They speak for themselves. Personally I did look at them, and I see no misstatement of fact in either one of those two articles.

Mr. COURTNEY. Mr. Chairman, I don't believe that even this Boeing letter, which I have just read for the third time, claims that there is any error of fact——

Mr. HÉBERT. As reported by the two press associations.

Mr. COURTNEY. As reported by either of these two very responsible and very old news services.

The complaint seems to be that the public got the wrong impression from the facts as reported and the committee is requested, I take it, to correct this false impression.

Mr. HÉBERT. We would be sitting up here day in and day out, I think, and all the year around, if we were to try to correct impressions that the public gets from any statement, whether it is newspapers, radio, magazines or television. It is not our province. I just wanted the record to show that the committee and certainly myself——

Mr. COURTNEY. I think it is way beyond the legislative province.

Mr. HÉBERT. If we try to have some thought control of the American public——

Mr. HARDY. Mr. Chairman, are we then in the position of even agreeing that there is any misrepresentation in these articles, although the fact may be correct, that there is any false impression created?

Personally, I don't see any evidence of a false impression.

Mr. HÉBERT. I don't see any either. That is the reason I wanted it definitely understood that the articles shall be in there.

This is merely an opinion expressed in a letter, and does not reflect the opinion of the committee. And also the committee is not even going to attempt to evaluate that opinion.

Mr. HARDY. Frankly, I have a hard time seeing how in the world anybody could arrive at it, but if they did it is all right with me.

Mr. GAVIN. Will the gentleman yield?

Mr. HÉBERT. Yes; certainly.

Mr. GAVIN. I would suggest we go back to Mr. Boeing, and ask him what he is talking about—the Boeing Airplane Co. and ask what they are talking about, about this false impression should be corrected.

Mr. COURTNEY. Mr. Gavin, if I may answer that question, I, of course, would have been responsible for doing that before we called this meeting, but on the fact of the record, and on the text of the letter, it appeared that the differences over whatever may exist with respect to the fact, and the impressions which flowed from them, are a controversy, if any, between the Boeing Airplane Co. and these two news services.

Mr. GAVIN. And what?

Mr. COURTNEY. And the two news services.

And perhaps the reading public of America, but in any event, they are certainly not the business of this submittee, in my considered view.

Mr. HÉBERT. I just want to make one comment on the letter of Boeing, in two instances, and that is that it is perfectly apparent to me that instead of cooperating, Boeing on three different occasions resisted further discussions on the basis that the Air Force auditor was expressing an opinion and not facts from the record.

Boeing on those three different occasions did resist any attempt to renegotiate the contract, which was a renegotiable contract.

And another point I want to make—and I think in fairness and in justice to the Air Force—that certainly my impression during the original testimony was that the Air Force had done nothing about the matter.

From this agreement of facts, it indicates that it was the Air Force representative who did initiate the suggestion that the contract be renegotiated, in view of the undue high profit.

Mr. COURTNEY. The suggestion was denominated an opinion, apparently, and not considered worthy of action.

Mr. HÉBERT. That is correct.

Mr. GAVIN. Unless the committee doesn't care to pursue the matter further, I don't know why we don't bring—have Mr. Clyde Skeen, controller of Boeing Airplane Co., come in here and let him explain these statements he is making here. They are going to be—let them come in here, and let them explain what they mean.

Mr. HÉBERT. Of course, if we get into a controversy on every matter as to what the American people think when they read newspaper accounts, we would be here forever.

Mr. HARDY. Mr. Chairman, may I make this particular point?

Mr. HÉBERT. Yes.

Mr. HARDY. Here is an opinion expressed by Boeing, an attempt to justify a position that is awfully tenuous to say the very least.

The American public can look at what they say and at the facts and judge for themselves.

Mr. HÉBERT. That is right.

Is that all, Mr. Courtney?

Mr. COURTNEY. That, Mr. Chairman, I would consider—unless you gentlemen care to hear from Mr. Skeen—I would consider a complete assembly of all of the facts related to this subject matter.

Mr. HÉBERT. I see where nothing could be gained by any further examination of it, except to make the record that we made today. So we will consider this matter closed as it is.

Mr. COURTNEY. Awaiting conclusions of the subcommittee.

Mr. Chairman, that is all—this, of course, is a public matter and was discussed and therefore, the entire factual presentation has been made in public.

Now, Mr. Chairman, we have two matters in executive session relating to prospective reports of the subcommittee.

Mr. HÉBERT. The subcommittee shall go in executive session.

(At 10:55 a. m., the subcommittee entered executive session.)

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